Sudan University of Science and Technology

College of Graduate studies

Evaluation of Diagnostic Performance of Computed Tomography in Diagnosis of Liver Diseases

تقويم اداء الاشعة المقطعية في تشخيص أمراض الكبد

Thesis Submitted for Fulfillment of PhD Degree in Diagnostic Radiology

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DeDication

To my parents,,,,,

To my husband,,,,

To my childern,,,,

Acknowledgement

First and above all, thanks and praises to Allah, the almighty for providing me this opportunity and granting me the capability to proceed successfully, and the prayers and peace be upon the merciful prophet Mohamed.

I want to express my sincere thanks and deep graduate to my faithful supervisor prof.Caroline Edward Ayad for guidance throughout this thesis and sharing her knowledge through the entire study.

I would also like to pass my special thanks to Dr. Husieun Ahmed Hassan , to my friends and colleagues whom help me in my thesis.

Iam sincerely thank the participants without whom the study would not have been feasible. The Sudan University of Science and Technology, College of Medical Radiological Science and Radiology,Ribat National University ,College of Medical Radiological Science and Nuclear Medicine, Department in Alfaisal Specialized Hospital, IbnAlhaitham Diagnostic Centre,

Antalya Medical Centre and Royal Care International Hospital are thankfully acknowledged

Abstract

This study was prospective study done in Sudan during the period from February 2014 to January 2017 at Alfaisal Specialized Hospital, Ibn alhaitham Diagnostic Centre, Antalya Medical Centre and Royal Care International Hospital.

The data were collected by using data collection sheet for 100 patients who were suspected to have liver disease. They have abdominal ultrasound (US) and abdominal computed tomography (CT) exam using triphasic scan protocol.

There was high frequency of diffused and focal liver lesions in Sudanese patient therefore, diagnosing and characterization of these lesions is essential.

The objectives of this study to characterize and diagnosis liver disease using multidetector computed tomography (MDCT) and evaluated the diagnostic performance of computed tomography (CT) and ultrasound (US) in diagnosing liver diseases.

All the data obtained in the study were documented and analyzed using Statistical Package for the Social Sciences (SPSS) program to test the significance of differences, p-value of less than 0.05 was considered to be statistically significant.

The study results were liver lesions were detected. The nature of the lesions was characterized in all phases of contrast. Enhancement patterns of benign disease, malignant and metastases were also been analyzed.

Triphasic CT scan results showed that 13(26.0%),of the lesions were well enhanced ,19(38%)were intermediately enhanced where 18(36%) reflect no enhancement in the arterial phase. lesions that still enhanced in the delay phase were(9/50/18%)constituting hemangioma8(16%) and liver tumors 1(2%);where in the venous phase the enhanced lesions constituting 30(60%) and including lesions of liver metastases.

Arterial and venous phase images are helpful in the detection of hyper vascular lesions and are essential for the characterization of a large proportion of lesions. Equilibrium phase images demonstrate benign focal liver lesions, and Triphasic liver (CT) enables characterization of a wide range of liver lesions and characterized them significantly at $p \leq 0.000$.

Also the study revealed significant relation between the enhancement, character of the lesions and the sonographic findings with the CT diagnosis at $p < .001$ and $p < .001$ and $p < 0.017$ respectively. Contrast-enhanced CT improves the diagnostic performance in liver lesions compared with baseline sonography.

ملخص البحث

هذه دراسة محتملية اجريت في السودان في الفترة من فبراير 2014م الي يناير 2017م في مستشفي الفيصل التخصصي ,مركز ابن الهيثم التشخيصي ,مركز انطاليا الطبي ومستشفي رويال كير العالمية.

تم جمع البيانات لعدد 100 مريض باستخدام ورقة جمع البيانات متوقع لديهم امراض بالكبد اجريت لهم موجات صوتية للبطن واشعة مقطعية للبطن ثم حللت بعد ذلك نتائج البيانات باستخدام برنامج الــحزم الاحصائية للعلوم الانسانية في التحليل الإحصائي ,لايجاد درجة التطابق اقل من 0.05 .

هنالك ترددات عالية لافات الكبد المتمركزة والمنتشرة في المرضي السودانيين من اجل ذلك تشخيص وتوصيف هدة الآفات مهم للغاية.

الهدف من هذه الدراسة توصيف وتشخيص امراض الكبد باستحدام الاشعة المقطعية متعدد الكواشف وتقويم الاداء التشخيصي للاشعة المقطعية والموجات فوق الصوتية في تشخيص امراض الكبد.

نتائج البحث وجدت كل الافات الكبدية عند المرضي, وصفت الافات جميعها في كل اطوار فحص التباين, وحللت نمط التحسينات للامراض الخبيثة والحميدة.اظهرت نتائج الشعة المقطعية ثلاثية الاطوار أن 13 من افات الكبد قد تباينت بنسبة 26% و19 منهم متوسطة التباين بنسبة 38% بينما 18 من هذه الافات ليس لها تباين بنسبة 36% في الطور الشرياني.الافات التي ظلت متباينة حتي طور التاخير بلغت 9حالات من 50حالة بنسبة 18% (8حالات منها الورم الوعائى الدموى وحالة واحدة ورم الكبد).اما في الطور الوريدي تباينت 30آفة من آفات الكبد بنسبة 60% مثلت اورام الكبد الخبيثة زات النمو الثانوي.

صور الطور الشرياني والطور الوريدي مفيدة في الكشف عن الافات زات الافراط الدموي وفي توصيف نسبة عالية من الافات. صور طور التوازن اظهرت افات الكبد االحميدة المتمركزة.وجدنا

ان الاشعة المقطعية ثلاثية الاطوار قادرة علي توصيف مجموعة واسعة من آفات الكبد بدرجة تطابق اقل من 0.00.

ايضا وجدت الدراسة تطابق بين اخز الافة لوسيط التابين وشخصية الآفة او المرض ونتائج الموجات فوق الصوتية بدرجة تطابق اقل من 001. واقل من 001. واقل من 0.017 علي التوالي.

الاشعة المقطية بوسيط التباين حسنت من الاداء التشخيصي لآفات الكبد مقارنة مع الموجات الصوتية الاساسية.

List of tables

List of figures

List of abbreviations

Abbreviation	Full name	page
MDCT	Multi detector Computed tomography	1
U/S	Ultrasound	1
HCC	Hepatocellular carcinoma	2
CT	Computed tomography	4
CM	Contrast media	4
Am	After morning	8
Fig	figure	8
HU	Hounsfield unit	12
cm	cintimeter	13
ERCP	Endoscopic retrograde cholipancreiatography	15
ADPKD	Autosomal-Dominant Polycystic Disease	16
MR	Magnetic resonance	19
MRI	Magnatic resonance imaging	19
DN	dysplastic nodule	23
RN	Regeneration nodules	23
WBC	White blood cell	25
IV	intravenously	25
MIP	maximum intensity projection	36
FNH	Focal nodular hyperplasia	38
KVP	Kilovolatage peak	41
MAS	Milliamper second	41
PACS	Picture archiving and communicating system	41

MRCP	Magnetic resonance cholangiopancreatography	53
PTC	Percutaneous transhepatic cholangiography	54

List of contents

CHAPTER ONE

Chapter one

1-1 introduction

Multiphasic contrast-enhanced dynamic computed tomography (CT) of the whole liver has played significant role in the examination for patients with liver disease. Hepatic lesions are difficult to distinguish with imaging criteria alone, however certain focal liver lesions have classic ultrasonic, computed tomographic (CT) characteristics It is important to emphasize that the primary objective in imaging the liver is to distinguish benign from metastatic and primary malignant lesion.Currently, there is no consensus concerning the optimal strategy for imaging the liver for focal liver disease.

Focal liver lesions can be distinct as any lesion in the liver other than the normal parenchyma with or without causing structural and functional abnormality of hepatobiliary system. (PremashisKar and Rajat Jain,2011)

Over the past few years, multi detector computed tomography (MDCT) technology has been introduced into clinical practice. (Baron R.L, et al 2001)

MDCT uses a bank of contiguous detectors to increase effective pitch by 4- to 16-fold, without consequent loss of spatial resolution along the axis of scanning. Single-detector computed tomography (CT) typically requires approximately 20 sec to completely scan the liver. Caudal sections of the liver (assuming craniocaudal scanning direction) often show mixed late arterial and early portal venous inflow phases. Multidetector technology

allows faster scanning of the liver so that more consistent, uniform hepatic enhancement is achieved during each phase of image acquisition; Although MDCT has been available in clinical practice for several years. (R.L Baron, et al 2001)

Multiphasic contrast-enhanced dynamic CT of the whole liver has
Played an important role as a screening examination for patients with cirrhosis or chronic hepatitis because hepatocellular carcinomas (HCCs) or premalignant nodules such as dysplastic nodules frequently develop in
Cirrhotic liver . Although classic HCCs are commonly hypervascular and tend to be seen best during the arterial phase of contrast enhancement,
Some well-differentiated HCCs or dysplastic nodules are relatively hypo vascular and often can be seen only on late phase images. (Furuta Akihiro and Ito Katsuyoshi, 2004)
The use of multirow detector CT (MDCT), which has advantages that include greater speed, thinner slices and multiphasic scanning, has improved the chance of detecting liver disease (hwang ,2012)
The advent of the multirow detector technique has lead to be naissance of CT in recent years, and with the exception of soft tissue and joint diagnostics, CT is now used as a basic approach to the whole body as radiography was in earlier years. Besides thoracic and vessel diagnostics, the assessment of the abdomen is the main role for CT examination, where the major indication is to detect or exclude and characterize focal liver lesions in patients where a primary malignancy is already known in order to search for metastasis and in individuals with a suspected tumor in order to discover the primary site of the malignancy. (Winterer et al, 2006)

CT scans of the liver and biliary tract (the liver, gallbladder, and bile ducts) can provide more detailed information about the liver, gallbladder, and related structures than standard X-rays of the abdomen, thus providing more information related to injuries and/or diseases of the liver and biliary tract.

CT scans of the liver and biliary tract may also be used to visualize placement of needles during biopsies of the liver or during aspiration (withdrawal) of fluid from the area of the liver and/or biliary tract. CT scans of the liver are useful in the diagnosis of specific types of jaundice (yellowing of the skin and eyes as a result of certain conditions of the liver).

Other related procedures that may be used to diagnose liver and biliary tract problems include abdominal X-rays, liver scan, gallbladder scan, abdominal ultrasound, and abdominal angiogram.
(www.hopkinsmedicine.org.com/healthlibrary/5/5/2014at 6.30Pm)

A CT scan of the liver and biliary tract may be performed to assess the liver and/or gallbladder and their related structures for tumors and other lesions, injuries, bleeding, infections, abscesses, unexplained abdominal pain, obstructions, or other conditions, particularly when another type of examination, such as X-rays, physical examination, and ultrasound is not conclusive.

A CT scan of the liver may be used to distinguish between obstructive and nonobstructive jaundice. Another use of CT scans of the liver and biliary tract is to provide guidance for biopsies and/or aspiration of tissue from the liver or gallbladder.
(www.hopkinsmedicine.org.com/healthlibrary/5/5/2014at 6.30Pm)

1-2 Problem of the study

This study determine that there was misdiagnosis in liver disease, because most of reports doesn't characterize the lesion in ideal triphasic protocol, enhancement and interaction of lesion with CM.mising one of the previous cannot reach to fully and true diagnosis of disease.

It is often difficult to characterize hepatic lesions and other liver disease with various imaging studies. And it is therefore important to differentiate between benign and malignant focal liver lesions for further management of the Patient. In our study we should determine diagnostic performance of MDCT in detection and differienation between all liver diseases.

1-3 Objectives:

1-3-1 General objectives:

To characterize the liver diseases using multidetector computed tomography (MDCT) and to know the diagnostic performance of triphasic spiral CT in differentiating benign from malignant focal liver lesions

1-3-2 specific objectives:

- To evaluate and characterize a wide range of liver disease by MDCT.

-To evaluate triphasic contrast enhanced spiral computed tomography (CT) in detection and characterization of focal liver lesions.

-To determine the clinical and radiological CT features that would enable the differential diagnosis between liver disease .

-To correlate between clinical finding, US and CT diagnosis.

-To correlate between enhancement pattern of liver disease with CT diagnosis.

-To characterize each disease contrast enhancement and interactions methods.

-To correlate between US findings and CT finding.

-To correlate between liver texture and constitution of lesions (homogenous and heterogenous) .

1-4 importance of the study

In study we used the spiral computed tomography (CT) because it has gained approval as the favorite CT technique for routine liver evaluation because it provides image acquisition at peak enhancement of the liver parenchyma (Bluemke DA and Fishman EK, 1993). 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 multiphasic liver CT.

The wide range of pathologic processes that may result in liver disease can present a difficult diagnostic conundrum. The radiologist must carefully assess such imaging features as location, size, and unifocal or multifocal nature of the cyst or cysts as well as evaluate cyst complexity and associated

findings. In addition, because radiologic features of various cystic liver lesions overlap, it is necessary to integrate imaging with clinical and laboratory findings to allow more definitive diagnosis.

To narrowing the differential diagnosis is to determine the presence or absence of complex features in liver disease, therefore we must solve and distinguish between these diseases as fast as possible to reach to best diagnosis in less time to decrease patient efforts. The aim was to evaluate the hepatic enhancement and interaction in patients with liver disease.

-the use of MDCT both facilitates more timely surgical interventional and reduces the number of patients requiring hospital admission.

1-5 Thesis over view

The study includes five chapters: Chapter one deal with introduction, problems of study, objectives and importance of the study. Chapter two literature review (anatomy, physiology, pathology, equipment, technique). Chapter three, material and methods. Chapter four presentation of the results. and chapter five discussion, conclusion, and recommendation. The last is references and appendices.

CHAPTER TWO

Chapter Two

Literature Review and Previous Study

2-1 Anatomy of the liver and biliary system

The liver is the largest gland in the body .liver is soft and pliable and occupies the upper part of the abdominal cavity just beneath the diaphragm.

The greater part of the liver is situated under cover of the right costal margin, and the right hemidiaphragm separates it from the pleura, lungs, pericardium, and heart. The liver extends to the left to reach the left hemidiaphragm.

The liver is the largest internal organ in the body. This dark reddish brown organ is located in the upper right qudarant of the abdominal cavity, beneath the diaphragm, and on top of the right kidney and intestines. liver weighs about 3 pounds. The liver may be divided into a large right lobe and a small left lobe by the attachment of the peritoneum of the falciform ligament. The right lobe is further divided into a quadrate lobe and a caudate lobe by the presence of the gallbladder, the fissure for the ligamentum teres, the inferior vena cava, and the fissure for the ligamentum venosum. The wedge-shaped liver consists of two main lobes, both of which are made up of eight segments that consist of 1,000 lobules These lobules are connected to small ducts that connect with larger ducts to ultimately form the hepatic duct. The hepatic duct transports the bile produced by the liver cells to the gallbladder and duodenum (the first part of the small intestine) .
(www.hopkinsmedicine.org.com/healthlibrary/15/5/2014 at 9:30Pm)

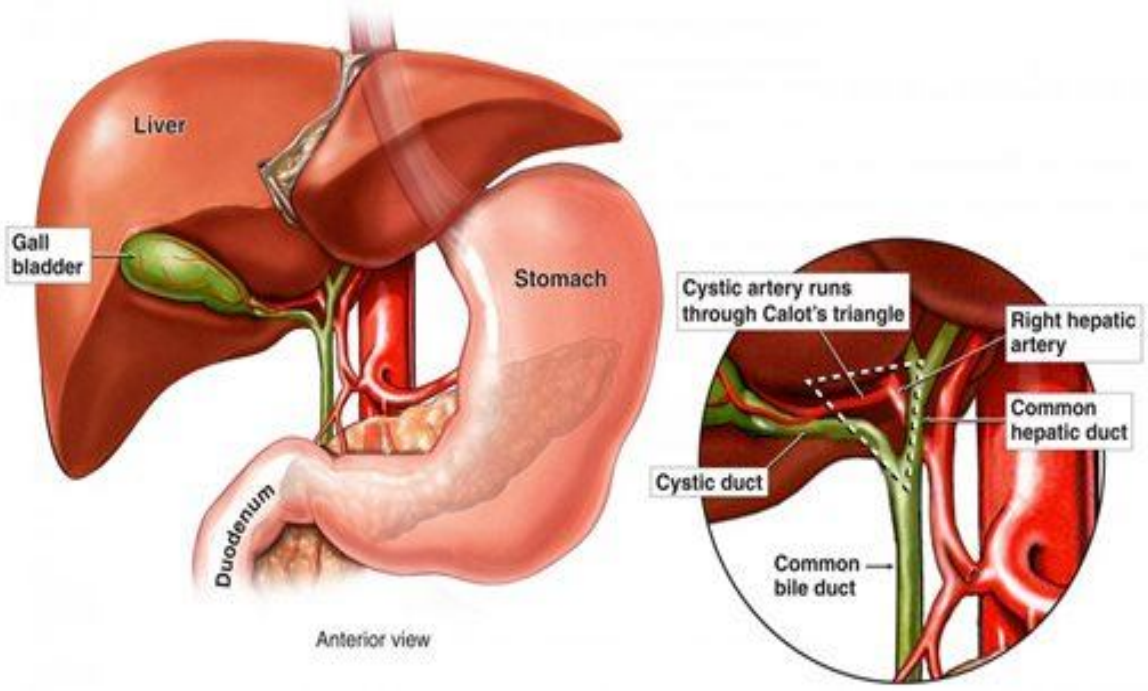


Fig 2-1 show liver and gall bladder and related anatomical structure.
(www.hopkinsmedicine.org.com/healthlibrary /15/5/2014 at 9:30 am)

The liver holds about one pint (13%) of the body's blood supply at any given moment. There are two distinct sources that supply blood to the liver, including the oxygenated blood flows in from the hepatic artery and nutrient-rich blood flows in from the hepatic portal vein. (Richard Snell,clinical antaomy by regions.9th edition pp169-170)

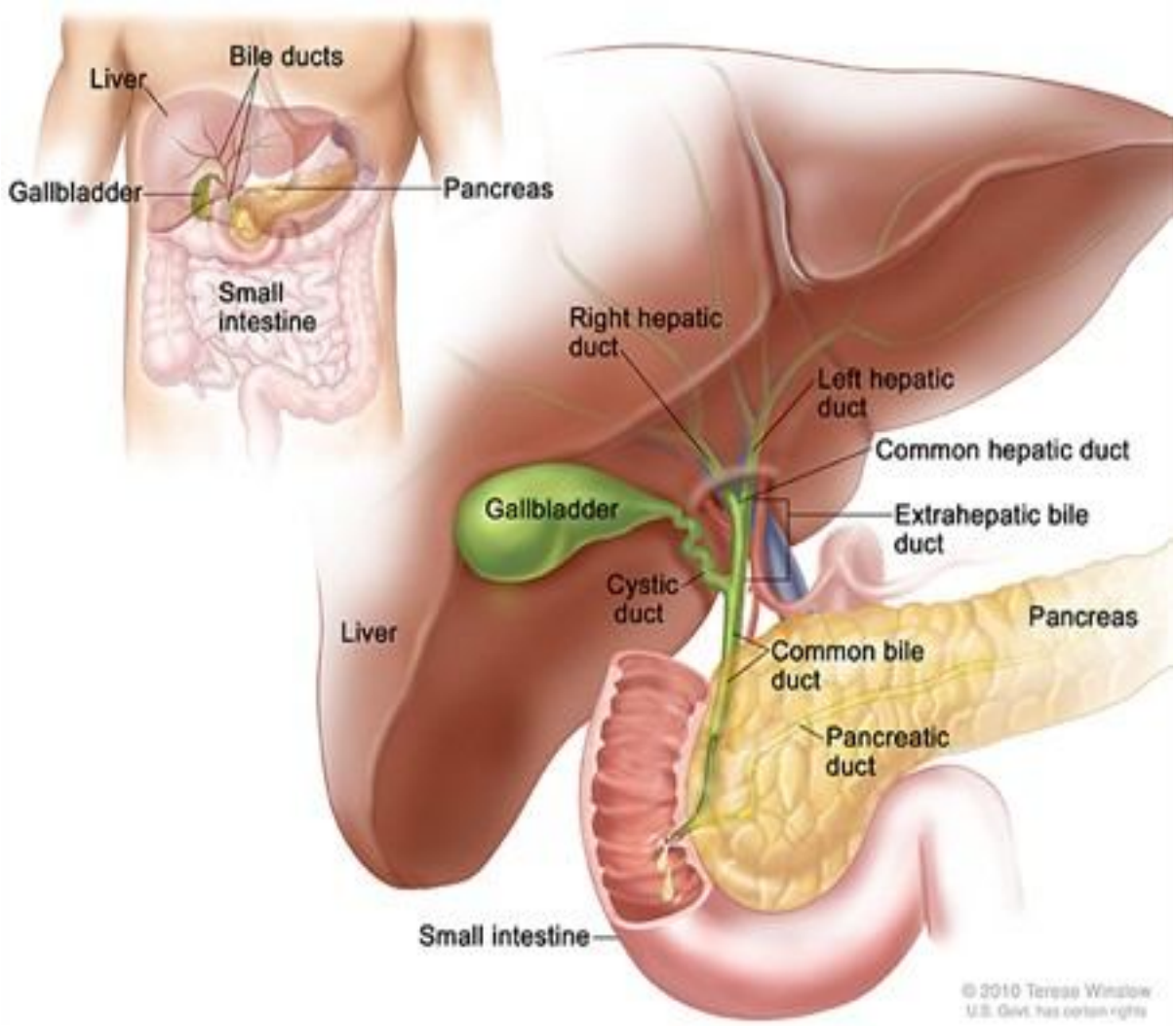


Fig 2-2 show liver and biliary ducts anatomy

(www.hopkinsmedicine.org.com/healthlibrary/15/5/2014 at 9:30 pm)

2-2 Functions of the liver

The liver regulates most chemical levels in the blood and excretes a product called bile, which helps carry away waste products from the liver. All the blood leaving the stomach and intestines passes through the liver. The liver processes this blood and breaks down, balances, and creates the nutrients

and also metabolizes drugs into forms that are easier to use for the rest of the body or that are nontoxic. More than 500 vital functions have been identified with the liver. Some of the more well-known functions include the following: Making bile. Fluid that helps break down fats and gets rid of wastes in the body , changing food into energy, clearing the blood of drugs and other poisonous substances ,producing certain proteins for blood plasma and regulating blood clotting

The biliary system consists of the organs and ducts (bile ducts, gallbladder, and associated structures) that are involved in the production and transportation of bile.
(www.hopkinsmedicine.org.com/healthlibrary/5/5/2014at 6.30Pm) .

Production of bile, which helps carry away waste and break down fats in the small intestine during digestion.

Production of cholesterol and special proteins to help carry fats through the body (www.hopkinsmedicine.org.com/healthlibrary /15/5/2014 at 9:30 pm).

Conversion of excess glucose into glycogen for storage (glycogen can later be converted back to glucose for energy) and to balance and produce glucose as needed.

Regulation of blood levels of amino acids, which form the building blocks of proteins (www.hopkinsmedicine.org.com/healthlibrary /15/5/2014 at 9:30 pm).

Processing of hemoglobin for use of its iron content (the liver stores iron).

Conversion of poisonous ammonia to urea (urea is an end product of protein metabolism and is excreted in the urine).

Clearing the blood of drugs and other poisonous substances.

Regulating blood clotting and resisting infections by producing immune factors and removing bacteria from the bloodstream.

Clearance of bilirubin, also from red blood cells. If there is an accumulation of bilirubin, the skin and eyes turn yellow.

(www.hopkinsmedicine.org.com/healthlibrary /15/5/2014 at 9:30 pm).

When the liver has broken down harmful substances, it's by-products are excreted into the bile or blood. Bile by-products enter the intestine and ultimately leave the body in the form of feces. Blood by-products are filtered out by the kidneys, and leave the body in the form of urine.(www.hopkinsmedicine.org.com/healthlibrary /15/5/2014 at 9:30 pm).

2-3 pathology of the liver

Liver disease can be divided into focal liver diseases and diffused liver diseases. Also liver disease can be divided into Cystic liver lesion and can be solid liver lesion. The cystic liver disease can divided into:

2-3-1 Simple cysts

Simple cysts appear as fluid-containing lesions with smooth thin walls and no evidence of complex internal features, such as septation and mural irregularity or nodularity. Simple cysts may be solitary or multifocal. The differential diagnoses for simple hepatic cysts include benign developmental

hepatic cyst, biliary hamartoma (von Meyenburg complex), Caroli disease, and autosomal polycystic liver disease. (Brookline Ave .2011).

2-3-1-1 Benign Developmental Hepatic Cyst

Benign developmental hepatic cyst is the second most common benign hepatic lesion (after cavernous hemangioma). As the name suggests, this is a benign, congenital, and developmental lesion derived from biliary endothelium that does not communicate with the biliary tree. It is currently thought that true hepatic cysts arise from hamartomatous tissue. Hepatic cysts are frequently multiple, usually asymptomatic, and discovered incidentally in the fifth to seventh decades of life. (Anderson SW etal (2009).

On CT, hepatic cysts are water-density (–10 to 10 HU) lesions with sharply defined margins and smooth thin walls (Fig. 2-3). They usually lack septa (although they may contain up to two) and do not show fluid–debris levels, mural nodularity, or wall calcification. (Anderson SW etal (2009).

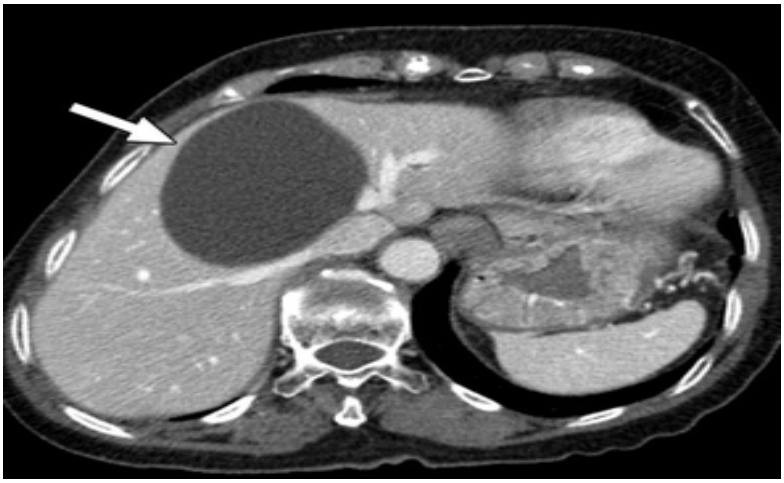


Fig. 2-3Benign developmental hepatic cyst. CT scan in 70-year-old man shows hypodense lesion (*arrow*) with sharply defined margins and smooth thin walls and no evidence of nodularity. (Anderson etal (2009).

Intracystic hemorrhage and infection are rare complications, resulting in complicated cysts. Large hepatic cysts can cause symptoms related to compression of adjacent intrahepatic ducts. Asymptomatic simple hepatic cysts require no further workup or treatment. (Anderson etal (2009).

2-3-1-2 Biliary Hamartoma/von Meyenburg Complex

Bile duct hamartomas, also known as von Meyenburg complexes, are rare benign malformations of the biliary tract that originate from embryonic bile ducts that fail to involute. They are usually asymptomatic and found incidentally on autopsy or at laparotomy(. Singh Yet al .(1997).

On CT, biliary hamartomas appear as multiple hypoattenuating lesions (< 1.5 cm) with margins that are more irregular than simple hepatic cysts. Compared with simple hepatic cysts, biliary hamartomas are more likely to be uniformly small and numerous, and they are typically smaller than the

hepatic cysts of autosomal-dominant polycystic kidney disease. The density of the lesion depends on the relative amounts of cystic and solid components. Predominantly cystic lesions show no contrast enhancement, whereas predominantly solid lesions enhance after contrast administration and become isodense with the liver parenchyma. On ultrasound, biliary hamartomas appear as small well-circumscribed lesions scattered throughout the liver, with hypoechoic, hyperechoic, or mixed echogenicity depending on solid, cystic, or mixed components, respectively.(Brookline Ave (2011).

Malignant transformation of biliary hamartoma to cholangiocarcinoma is extremely rare. An isolated finding of biliary hamartomas in a healthy patient requires no further diagnostic workup or treatment. .(Brookline Ave (2011).

2-3-1-3 Caroli Disease

Caroli disease, also known as congenital, communicating, cavernous ectasia of the biliary tract, is an autosomal-recessive disorder characterized by multifocal saccular dilation of the intrahepatic bile ducts. The more common form of the disease is associated with periportal fibrosis and may progress to portal hypertension and cirrhosis. The rarer “pure/simple” form is associated with intrahepatic stone formation, cholangitis, and abscess formation. Caroli disease is often associated with cystic renal disease, particularly medullary sponge kidney. Cholangiocarcinoma may develop in up to 7% of cases.

The characteristic CT appearance is multiple hypoattenuating cystic structures of varying size that communicate with the biliary system. A finding highly suggestive of Caroli disease is the “central dot sign,” in which

tiny foci of strong contrast enhancement within dilated intrahepatic bile ducts correspond to intraluminal portal vein radicals (Fig. 2-4). Endoscopic retrograte cholipancriatography (ERCP) and cholangiography are helpful for confirming communication of the cystic structures with the biliary tree (Fig. 2-5). (Singh Yet al .(1997).

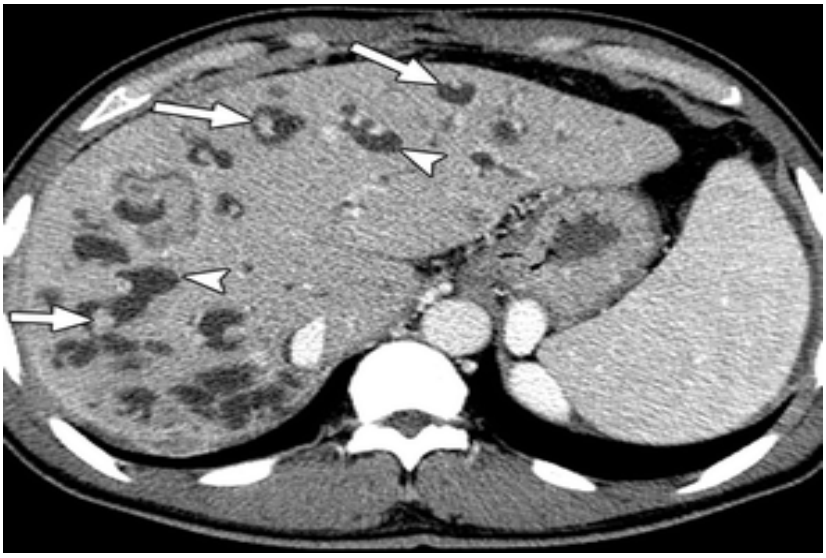


Fig. 2-4Caroli disease in 35-year-old man. Contrast-enhanced portal venous phase CT scan shows saccular dilations of biliary tree (*arrowheads*) with enhancement of central portal vein radicals ("central dot sign") (*arrows*). (Singh et al .(1997).

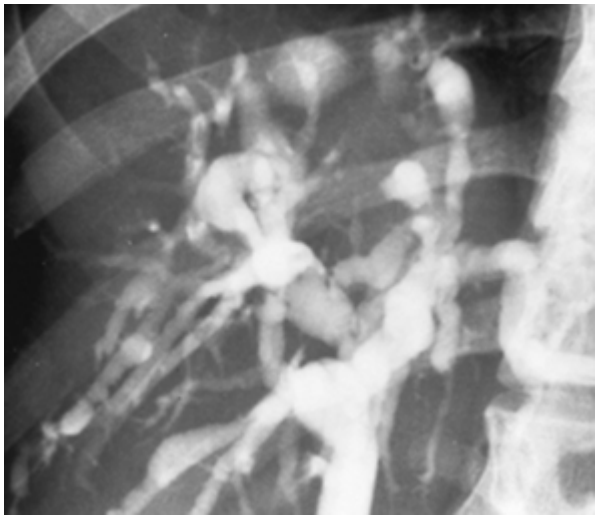


fig. 2-5 Caroli disease in 35-year-old man. Cholangiogram shows characteristic dilation of intrahepatic ducts. (Singh et al .(1997).

Caroli disease can be diffuse or segmental. If the disease is localized to a lobe or segment, the treatment of choice is hepatic lobectomy or segmentectomy, respectively. Treatment options for more diffuse disease include conservative management, decompression of the biliary tract, orliver transplantation..(Singh et al .(1997).

2-3-1-4 Autosomal-Dominant Polycystic Disease

The presence of numerous hepatic cysts may be due to involvement by autosomal-dominant polycystic liver disease. Hepatic polycystic disease is seen in up to 40% of patients with autosomal-dominant polycystic kidney disease (ADPKD) but may also occur in the absence of renal cysts. Pathologically, the liver cysts are thought to represent ductal plate malformations (cystic dilations of von Meyenburg complexes). In hepatic involvement of ADPCKD, the development of peribiliary cysts may represent cystic dilation of peribiliary glands. Patients with hepatic

involvement of ADPCKD can be asymptomatic or present with right upper quadrant pain. There is no sex predominance. .(Brookline (2011).

In autosomal polycystic liver disease, the numerous hepatic cysts of various sizes have features identical to those described for benign developmental hepatic cysts—well-circumscribed round lesions that are hypodense and nonenhancing at CT.When numerous, the cysts may appear polygonal if partially compressed by adjacent cysts. Cyst complications, such as internal hemorrhage, may be more common in autosomal polycystic liver disease because of the increased number of lesions.ADPKD requires no treatment. Symptomatic disease is managed with exploratory laparotomy and surgical resection. .(Brookline (2011).

2-3-2 Complex Cysts

Complex cysts are fluid-containing hepatic lesions with one or more of the following complex features: wall thickening or irregularity, septation, internal nodularity, enhancement, calcification, and hemorrhagic or proteinaceous contents. Because a broad range of disease processes can result in complex cystic liver lesions, they may be further grouped as neoplastic, inflammatory or infectious, and other miscellaneous entities. A careful evaluation of particular imaging features as well as associated radiologic and clinical and laboratory findings is necessary to suggest a specific diagnosis. .(Brookline (2011).

2-3-2-1 Neoplastic

2-3-2-1-1 Biliarycystadenoma and biliary cystadenocarcinoma

Biliary cystadenoma and biliary cystadenocarcinoma are premalignant and malignant cystic biliary ductal neoplasms, respectively, that account for fewer than 5% of intrahepatic cystic lesions of biliary origin. They arise mainly from the intrahepatic ducts and rarely from the extrahepatic ducts or gallbladder. These neoplasms are most frequently found within the right lobe of the liver (55%) but also may involve the left lobe (29%) or both lobes (16%). Biliary cystadenoma presents predominantly in middle-aged white women with abdominal pain, nausea, vomiting, and obstructive jaundice.

The characteristic CT appearance is a solitary complex cystic mass with a well-defined thick fibrous capsule, internal septations, and mural nodularity (fig 2-6)

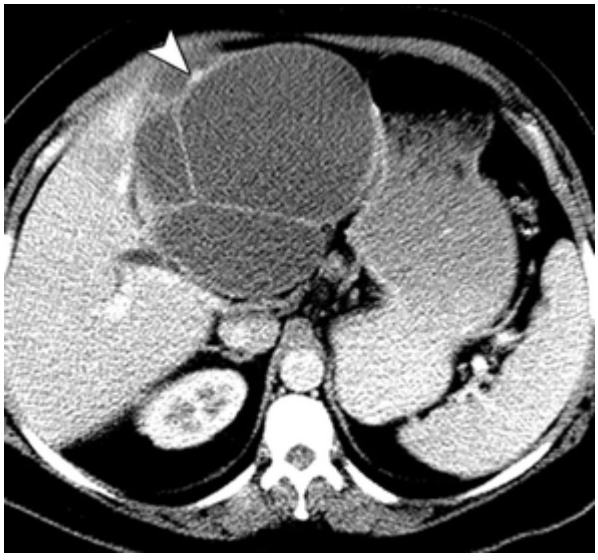


Fig. 2-6Biliarycystadenoma in 47-year-old woman. Contrast-enhanced CT scan shows multiseptated cystic lesion in left lobe of liver. Note focal papillary excrescence (arrowhead).(Singh et al .(1997).

The key difference between biliary cystadenoma or biliary cyst adenocarcinoma and a hemorrhagic or infected hepatic cyst is that the capsule, internal septations, and mural nodules show contrast enhancement in the former and do not in the latter. (DelPoggioP,and Buonocore.(2008).

Imaging characteristics cannot definitely distinguish biliary cystadenoma from biliary cystadenocarcinoma. Therefore, the optimal management of these masses is surgical resection . (Anderson etal .(2009).

2-3-2-1-2 Cystic metastases

Hepatic metastases may appear cystic either due to necrosis and cystic degeneration of rapidly growing hypervascular tumors (sarcoma, melanoma, carcinoid, neuro endocrine tumors, and some lung and breast tumors) or as a manifestation of mucinous colonic or ovarian adenocarcinomas. (Brookline (2011)

On ultrasound, CT, and MRI, cystic metastases appear as solitary or, more commonly, multifocal lesions with complex features, such as thick, irregular, enhancing walls; thick or nodular septations; mural nodularity; or internal debris (Fig. 2-7). Ovarian metastases spread by peritoneal seeding and therefore result in cystic serosal implants on both the visceral peritoneal surface of the liver and the parietal peritoneum of the diaphragm rather than as intraparenchymal masses. (Brookline (2011)

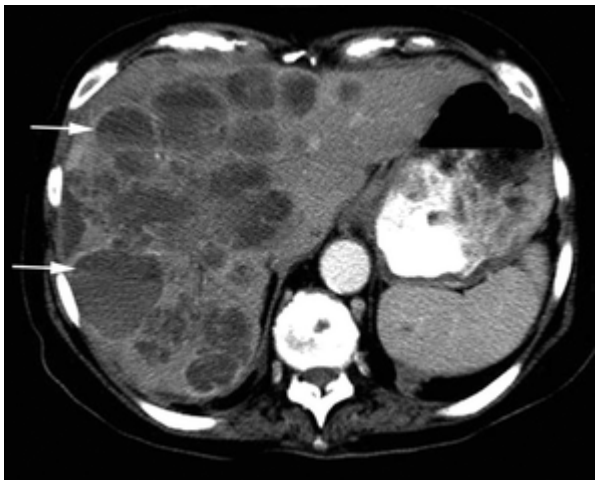


Fig.2-7 Hepatic cystic metastases in 53-year-old man. Multiple hypodense hepatic masses represent melanoma metastases with internal cystic change due to necrosis and hemorrhage. Fluid–fluid levels (arrows) in multiple lesions indicate hemorrhagic contents. (Anderson etal (2009).

A clinical history of a known primary malignancy, particularly in the setting of multifocal lesions, may help to suggest the diagnosis of cystic hepatic metastases, which can be confirmed with imaging-guided biopsy.(Brookline (2011).

2-3-2-1-3 Cystic hepatocellular carcinoma

A Cystic subtypes of hepatocellular carcinoma (HCC) are rare. They usually are related to internal necrosis and cystic degeneration in rapidly growing tumors. CT and MRI findings that permit differentiation of cystic HCC from other cystic lesions of the liver include underlying liver cirrhosis and such intrinsic tumor characteristics of HCC as hypervascularity of solid components and tumor invasion of the portal and hepatic veins (Fig. 2-8). After radiofrequency ablation therapies for HCC, the post procedure

liquefactive necrotic cavity may partly or completely consist of fluid remnants of tissue and may resemble a cystic lesion. .(Brookline (2011).

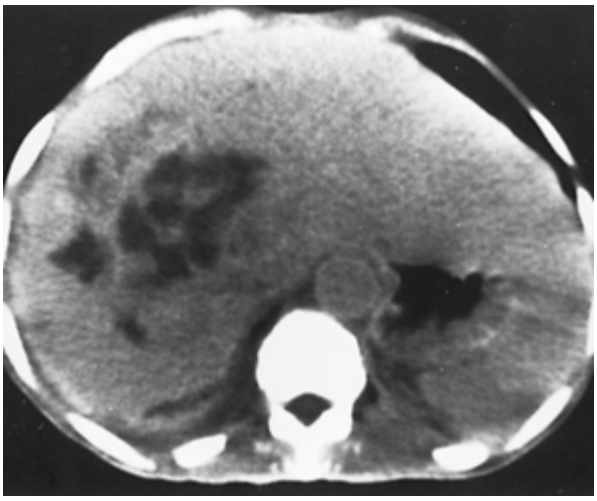


Fig.2-8Cystic hepatocellular carcinoma in 60-year-old man with known hepatocellular carcinoma. CT scan shows multiple low-attenuation masses in liver. (Brookline (2011).

2-3-2-1-4 Cavernous hemangioma

Giant cavernous hemangioma is another primary hepatic neoplasm that can outgrow its blood supply and show central cystic degeneration. This tumor frequently occurs in middle-aged women. The vast majority of hemangiomas (as many as 85%) are asymptomatic; however, they may cause symptoms because of the compression of adjacent structures, rupture, or acute thrombosis.

At ultrasound, giant cavernous hemangioma with central cystic necrosis may share some features with more typical hemangiomas, such as a well-circumscribed echogenic periphery with a hypoechoic center (“reverse

target” sign). However, the appearance may not be diagnostic. The central cystic component appears hypodense on unenhanced CT and on all phases of contrast-enhanced dynamic examination (Figs. 2-9, 2-10, and 2-11). On contrast-enhanced CT and MRI, even hemangiomas with predominantly cystic components continue to show the characteristic peripheral nodular enhancement pattern that helps make the diagnosis. Symptomatic large lesions may require surgical resection. .(Brookline (2011).

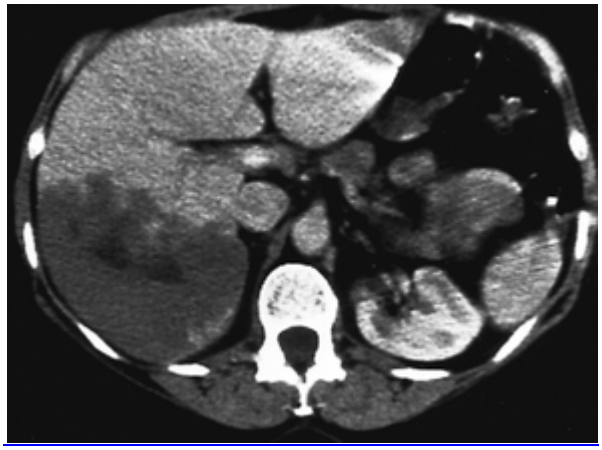


Fig. 2-9Cavernous hemangioma in 50-year-old woman. Initial CT scan after bolus injection of contrast material shows low-attenuation lesion in posterior segment of right lobe of liver. (www.ajronline.org/27/9/2014 at 5:00pm)

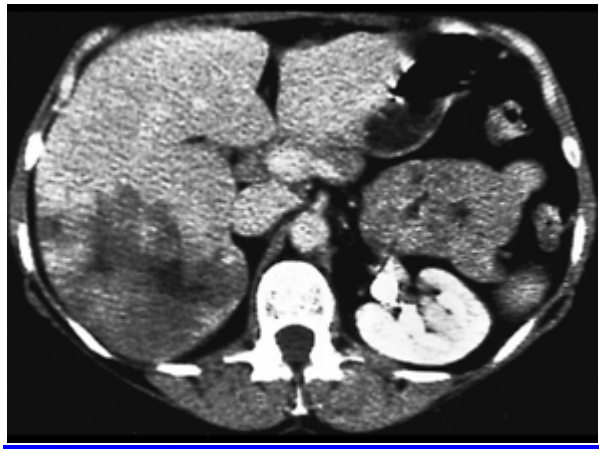


Fig. 2-10 Cavernous hemangioma in 50-year-old woman. Delayed CT scans show progressive enhancement of lesion until it becomes nearly isodense with normal hepatic parenchyma.

(www.ajronline.org/27/9/2014 at 5:00pm)

2-3-2-1-5 Embryonal sarcoma

Embryonal sarcoma is a rare malignant tumor that usually presents in older children and adolescents but can occur in adult patients. Although the lesion is predominantly solid on gross pathologic examination, it paradoxically presents at CT as a large cystic-appearing mass. This appearance results from the high water content of the myxoidstroma, which causes the lesion to appear hypodense on unenhanced CT. On contrast-enhanced CT, there is heterogeneous enhancement, usually involving the peripheral portions of the mass (Fig.2-11).. The presence of internal enhancement on contrast-enhanced CT is another feature that may distinguish this lesion from a frankly cystic mass. (Anderson etal .(2009).

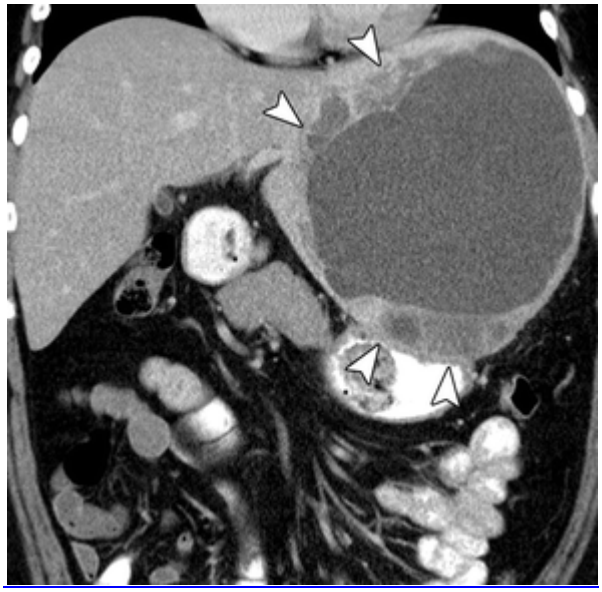


Fig2-11 Embryonal sarcoma in 17-year-old boy. Contrast-enhanced CT scan shows cystic lesion within left lobe of liver with heterogeneous irregular enhancement of peripheral portions of mass (*arrowheads*).

(www.ajronline.org/27/9/2014 at 5:00pm)

2-3-2-2 Inflammatory or Infectious Cysts

2-3-2-2-1 Abscess

A hepatic abscess is a localized collection of pus in the liver, with associated destruction of the hepatic parenchyma and stroma. Hepatic abscesses may be further classified as pyogenic, amebic, or fungal. Because amebic abscesses do not require drainage, it is important to distinguish them from pyogenic abscess, which can be established on the basis of clinical, radiologic, and serologic data. (www.ajronline.org/27/9/2014 at 5:00pm)

Pyogenic abscesses most commonly occur as complications of ascending cholangitis or portal phlebitis. Common causative organisms include Escherichia coli, Clostridia species, Staphylococcus aureus, and Bacteroides

species. Clinically, pyogenic abscesses usually manifest in middle-aged or elderly patients who present with fever, right upper and lower quadrant pain, tender hepatomegaly, and elevated WBC counts. On CT, these abscesses appear as well-defined hypoattenuating masses (0–45 HU) with peripheral rim enhancement after the administration of IV contrast material. A characteristic CT finding is the “cluster of grapes” sign, which represents the coalescence of small pyogenic abscesses into a single large multiloculated cavity. The presence of gas within an abscess may be due to infection by gas-forming organisms such as Clostridia species and is strong evidence for pyogenic rather than amebic abscess. The “double target” sign (hypodense rim, isodense periphery, and decreased attenuation in the center) is also characteristic of complex pyogenic abscess. (www.ajronline.org/27/9/2014 at 5:00pm)

Amebic liver abscesses, caused by Entamebahistolytica, are the most frequent extracolonic complication of amebiasis. Clinically, in addition to tender hepatomegaly, right upper quadrant abdominal pain, and diarrhea, patients with amebic abscesses often have a history of travel to an endemic area and positive amebic serology. The radiologic features of amebic and pyogenic abscesses often overlap, necessitating clinical and serologic data for diagnosis. Gas is usually not present within an amebic abscess unless there has been development of a hepatobronchial or hepatoenteric fistula. Unlike pyogenic abscesses, amebic abscesses rarely need therapeutic drainage and are frequently effectively managed with only metronidazole therapy. (www.ajronline.org/27/9/2014 at 5:00pm)

Fungal abscesses due to Candida species are seen in immune-compromised patients. CT shows multiple low-attenuation lesions, which typically have rim enhancement and often also involve the spleen. (Brookline (2011).

2-3-2-2-2 Echinococcal cysts

Hepatic echinococcosis, or hydatid disease, is caused by the larval stage of the tapeworm Echinococcusgranulosis (more common) or E. multilocularis (more aggressive). After the patient ingests eggs of E. granulosis or E. multilocularis by eating contaminated food or by contact with dog excrement, the larvae invade the intestinal wall and gain access to the liver (via the portal vein), where they develop into hepatic hydatid cysts. Each hydatid cyst consists of an outer pericyst (compressed and fibrotic host liver tissue), middle laminated membrane or ectocyst, and inner germinal layer. Together, the middle laminated membrane and inner germinal layer are referred to as the endocyst. Daughter cysts develop on the periphery as a result of germinal layer invagination. (Brookline (2011).

Clinically, echinococcal cysts are predominantly seen in middle-aged patients who present with right upper quadrant abdominal pain and jaundice.

On CT, hydatid cysts appear as large unilocular or multilocular hypoattenuating liver cysts. One half of them have crescentic mural calcifications. Daughter cysts are seen as round peripheral structures that may have lower attenuation than fluid within the mother cyst. In the absence of daughter cysts, it may be difficult to differentiate an echinococcal cyst from a cystic metastasis or pyogenic abscess radiographically without clinical and serologic data. However, in E. multilocularis infection there is

little or no contrast enhancement, reflecting the poor vascularity of the parasitic lesion. (Brookline (2011).

On ultrasound, *E. granulosis* infection typically appears as a multiseptate cyst with daughter cysts and echogenic material between them (Fig. 2-12). (Mortele and Ros.(2002).

Complications of hydatid cysts include bile duct compression and rupture into the biliary tree with resulting cholangitis. Treatment strategies include medical therapy (albendazole or mebendazole), drainage or surgical resection, or even liver transplantation. (Mortele and Ros.(2002).

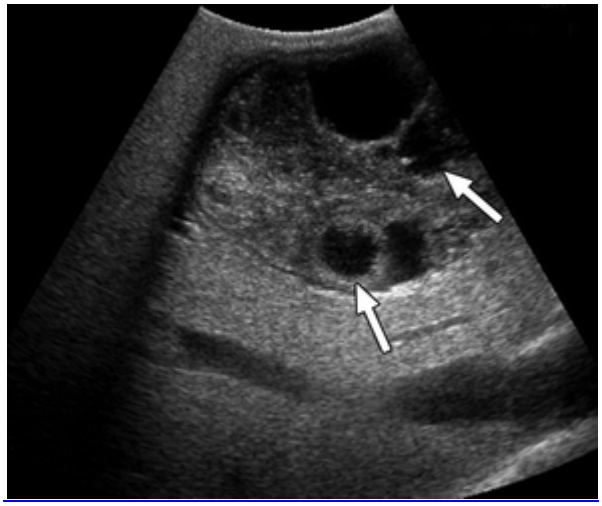


Fig. 2-12 Echinococcal cyst. Transverse intraoperative ultrasound image in another patient obtained at time of resection shows complex mass in liver, representing hydatid cyst. Multiple daughter cysts are seen about periphery of lesion. (www.ajronline.org/27/9/2014 at 5:00pm)

2-3-2-3 Postraumatic and Miscellaneous Cysts

2-3-2-3-1 Hepatic extrapancreatic pseudocyst

Hepatic extrapancreaticpseudocysts occur predominantly in the left lobe of the liver and are secondary to an extension of fluid from the lesser sac into the hepatogastric ligament. The clinical symptoms are related to the underlying pancreatitis, with associated elevated amylase levels. (Brookline (2011).

On CT, chronic or sub acute pseudocysts appear as well-defined homogeneous sub capsular cystic masses within the liver (Fig. 2-13). In the more acute phase, pseudocysts may show irregular margins with adjacent inflammatory stranding. Intrahepatic pseudocysts are less common than subcapsular lesions but are less common. The CT and MRI visualization of imaging findings consistent with associated pancreatitis is valuable for making the correct diagnosis. In some cases of hepatic extra pancreaticpseudo cyst, percutaneous drainage may be required. (Brookline (2011).

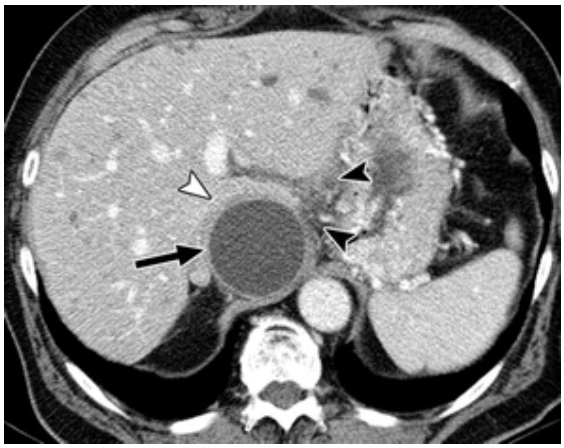


Fig. 2-13 Pseudocyst related to prior episode of pancreatitis in 45-year-old man. Axial contrast-enhanced CT image of liver shows round low-attenuation lesion centered in subcapsular region of caudate lobe (arrow). Mass has thick peripheral rim (white arrowhead) and adjacent

inflammatory fat stranding (black arrowheads).
(www.ajronline.org/27/9/2014 at 5:00pm)

2-3-2-3-2 Hepatic hematoma

Intrahepatic or perihepatic hematomas usually develop secondary to surgery, trauma, or hemorrhage within a solid liver neoplasm (especially HCC). Clinically, these lesions may produce signs and symptoms related to blood loss, peritoneal irritation, right upper quadrant tenderness, and guarding. Elevated liver enzymes in a patient with blunt abdominal trauma is suggestive of liver injury, although preexisting hepatic disease may be responsible for abnormalities in liver function tests. (Brookline (2011).

On CT, a hepatic hematoma is a fluid collection within the liver that has a higher attenuation value than pure fluid in the acute or subacute setting but an attenuation value identical to pure fluid in chronic cases (Brookline (2011).

2-3-2-3-3 Biloma

A biloma is an encapsulated collection of bile outside the biliary tree. It can develop spontaneously, be secondary to trauma, or represent an iatrogenic complication after an interventional procedure or surgery. Leakage of bile within the liver parenchyma induces an inflammatory response, which may result in the formation of a well-defined pseudocapsule. (Brookline (2011).

On CT and MRI, a biloma appears as a well-defined or slightly irregular cystic lesion without septations, calcifications, or a true capsule .The management of bilomas includes percutaneous drainage of the fluid collection and ERCP with stent placement to improve biliary drainage and prevent further bile leakage. (Brookline (2011).

2-3-2-3-4 Complicated infectious and hemorrhagic cysts

As the name suggests, infection or hemorrhage into a simple hepatic cyst results in the development of a complex cystic lesion, which may be indistinguishable from a cystic tumor. Unlike simple cysts, infected or hemorrhagic livers cysts present clinically with pain and fever.

On ultrasound, hemorrhagic cysts appear as hypoechoic lesions with increased through transmission of sound and lack of internal vascularity, suggesting their cystic nature (Fig. 2-14).

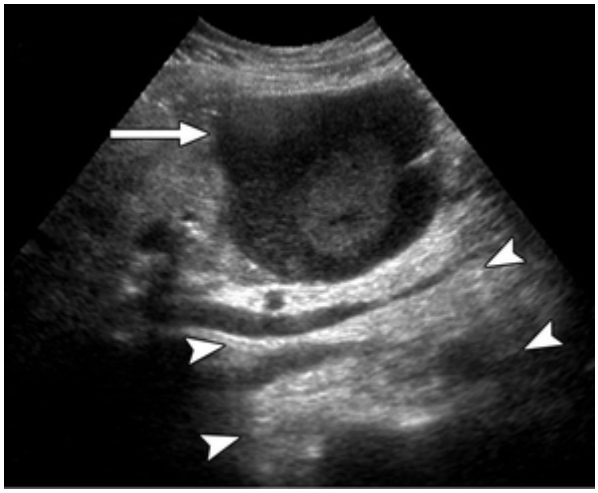


Fig. 2-14 Hemorrhagic hepatic cyst in 78-year-old woman. Transverse ultrasound image shows left lobe hepatic cyst with hypoechoic internal contents (arrow) and increased through-transmission of sound (arrowheads). (www.ajronline.org/27/9/2014 at 5:00pm)

On CT, the characteristic appearance is a complex cystic lesion with variable features, which may range from cysts with internal hemorrhagic components to more complex cystic masses with a thick well-defined fibrous capsule, internal septations, and mural nodularity. The appearance may mimic biliary cystadenoma or biliary cystadenocarcinoma, but an

infected or hemorrhagic cyst does not show any contrast enhancement. (Singh et al .(2002).

The management of a large symptomatic complicated hepatic cyst may include percutaneous drainage, surgical resection, or marsupialization (Singh et al .(2002).

2-3-2-3-5 hepatic cirrhosis

Hepatic cirrhosis is the clinical and pathologic result of a multifactorial chronic liver injurycharacterized by extensive fibrosis and nodular regeneration replacing the normal liver parenchyma. It is well known that cirrhosis is the origin of multiple extrahepatic abdominal complications and a markedly increased risk of hepatocellular carcinoma (HCC).This tumor is the sixthmost common malignancy worldwide and the thirdmost common cause of cancer related death.With the rising incidence of HCC worldwide, awareness of the evolution of cirrhotic nodules into malignancy is critical for an early detection and treatment. Adequate imaging protocol selection with dynamic multiphase Multidetector Computed Tomography (MDCT) and reformatted images is crucial to differentiate and categorize the hepatic nodular dysplasia. Knowledge of the typical and less common extrahepatic abdominal manifestations is essential for accurately assessing patients with known or suspected hepatic disease. (Brown, Naylor, Yagan. (1997).

The detection of hepaticmalignancy in cirrhotic patients is a diagnostic challenge due to distortion of the hepatic architecture (Brancatellietal ,(2003)

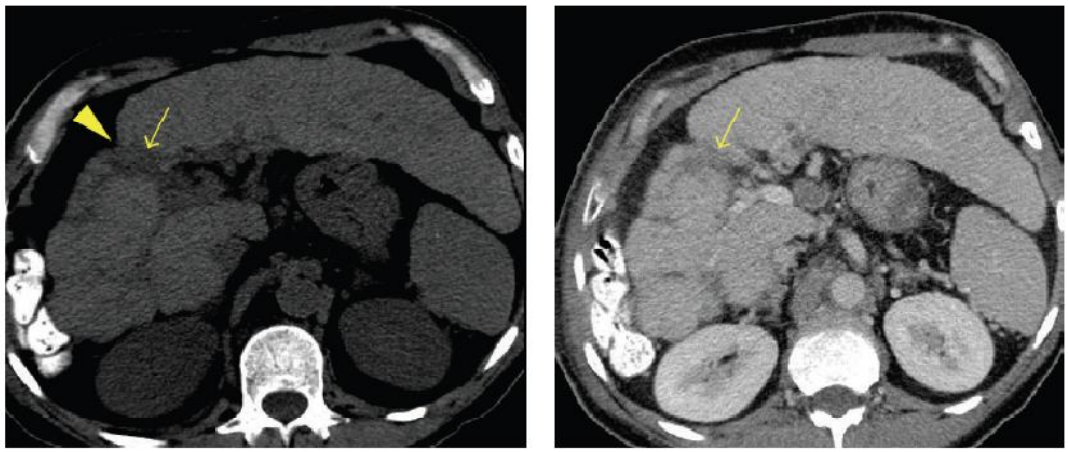


Fig 2-15 Confluent fibrosis in a 55-year-old male with alcoholic cirrhosis. (a) An unenhanced axial CT image shows a v-shaped area of subtle hypoattenuation (arrow) in hepatic segment 5. Note the retraction of the hepatic contour (arrowhead). (b) A portal venous phase axial image obtained at the same level as image (a) reveals an area of decreased portal venous flow (arrow).(www.ajronline.org/30/9/2014 at 7:38 am)

Hepatic steatosis is a nonspecific reversible response of hepatocytes to chronic injury, commonly seen in alcoholinduced cirrhosis. A diffuse uniform fatty infiltration involving the entire liver is the most common pattern. When hepatosteatosis occurs, the average liver attenuation is at least 10 Hounsfield Units (HU) less than the splenic parenchyma on unenhanced CT (Mergoetal (1994) .

The identification of normal course vascular structures in areas of fatty infiltration is crucial to differentiate this abnormality from hepatic tumors. Evolving hepatic nodular lesions are another important feature of cirrhosis. In attempt to standardize the terminology, an international working party has suggested terms and definitions of nodular lesions in cirrhotic patients.These

are categorized as regenerative nodules, dysplastic nodules, and HCC (Wanless et al.(1995).

2-3-2-3-5-1 Regenerative nodule

A regenerative nodule (RN) is a well-defined area of liver parenchyma that has enlarged in response to necrosis and altered circulation. Based on grossmorphologic features, the nodular regeneration can be classified as micronodular (<3mm in diameter) or macronodular (>3mmin diameter).

Unless a regenerative nodule contains iron, it is rarely seen on a noncontrast CT (Dodd II Ietal .(1999).

If iron deposition is present (siderotic nodule), the nodule appears hyperdense to the surrounding liver on a non-contrast CT

Micronodular changes are rarely identified on CT, despite being present in all cirrhotic livers . (Dodd II Ietal . (1999).

Regenerative nodules do not enhance in the arterial phase and are isodense to the remaining parenchyma on the venous phase, making them indistinguishable from the hepatic back ground.The accuracy of non-contrast CT in detecting a RN is approximately 25%.(Dodd II Ietal . (1999).

A combination of micro- and macro nodular regeneration is the most common morphologic presentation seen in cirrhotic patients. (Dodd II Ietal . (1999).

2-3-2-3-5-2 A dysplastic nodule

A dysplastic nodule (DN) is defined as a nodular region of dysplastic hepatocytes without histologic features of malignancy. DNs commonly measure 5–10mm and most of them are undetectable by CT since, even after the administration of contrast, the majority is iso attenuating. Dysplastic

nodules can be further characterized as low grade or high grade, according to the degree of dysplasia .(Wanless et al. (1995).

Tumor angiogenesis appears to be a mandatory step in the evolution of dysplastic nodules to HCC. During this process, there is a progressive increase in the arterial supply and a concomitant decrease in the portal venous supply to these lesions .(Matsui, et al.(2009).

2-3-2-3-5-3 hepatocellular carcinoma (HCC)

HCC is a malignant neoplasm composed of cells with hepatocellular differentiation and is almost exclusively seen in patients with cirrhosis. The development of HCC in the cirrhotic liver is described either as de novo hepatocarcinogenesis or as a multistep progression, from low-grade dysplastic nodules to high-grade dysplastic nodule, then to dysplastic nodule with microscopic foci of HCC, then to small HCC, and finally to overt carcinoma (Coleman.(2003).

HCC is classified histologically as trabecular, pseudoglandular, compact, and scirrhous, with the trabecular pattern being themost common. The fibrolamellar type of HCC has distinct clinical, histologic, and prognostic features and is commonly seen in young patients with no history of cirrhosis or chronic liver disease. The lesion appearance varies greatly according to size (Baron and Peterson.(2001).

Small lesions enhance homogeneously, while large lesions are heterogeneous with a characteristic mosaic pattern, due to intra lesional necrosis. Approximately 80%–90%ofHCCs are highly vascular lesions demonstrating intense contrast enhancement during the arterial phase. In the venous phase, HCC demonstrates washout and becomes isodense with the liver parenchyma, there by making its detection difficult. (Baron, etal (1996).

About 10%–20% of HCCs are hypovascular and show contrast enhancement slightly less than that in the surrounding liver on arterial phase images HCC may present as a solitary mass (Figure 2-16), a dominant mass with daughter lesions (multicentric type) (Figure 2-17), or as a diffusely infiltrating neoplasm (Figure 2-18).

Less frequently, it is multifocal with small foci usually less than 2 cm in both hepatic lobes, which may mimic liver metastasis (Dodd II Ietal . (1999).

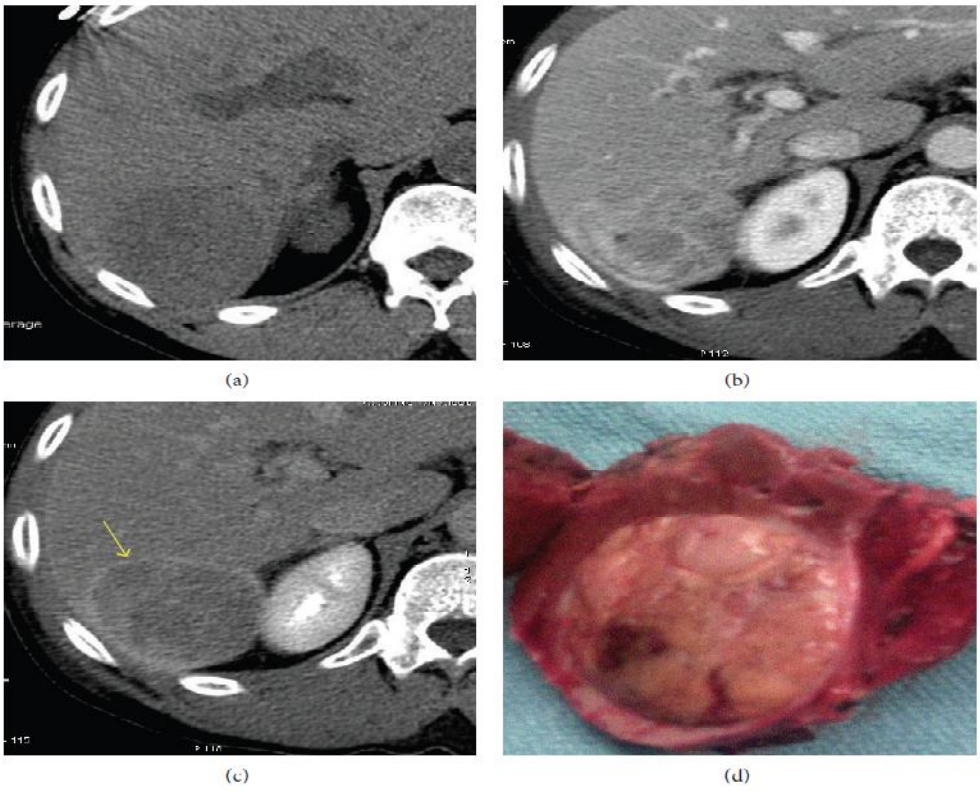
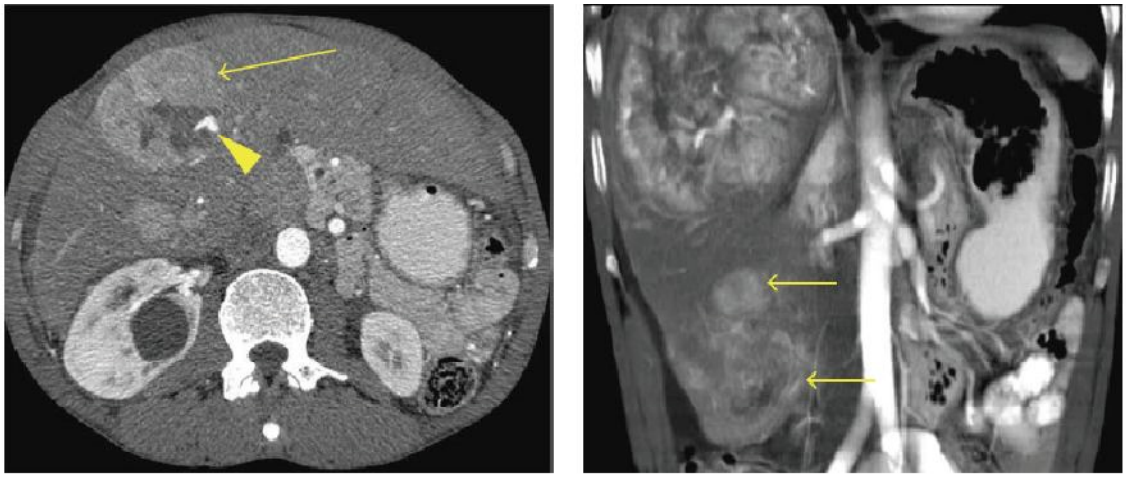


Fig 2-16: Solitary HCC. Axial CT images of the right hepatic lobe during precontrast (a), postcontrast venous (b), and delayed (c) phases show a well-defined heterogeneous solid enhancing mass occupying hepatic segment 7. Note the delayed enhancement of the lesion capsule.

(c), arrow). (d) Photograph of the surgical specimen.

(www.ajronline.org/27/9/2014 at 5:00pm)



(a) (b)

Fig 2-17:Multicentric HCC with a variegated appearance. (a) Arterial phase contrast-enhanced axial CT image shows a large heterogeneous mass that enhances intensely with multiple adjacent nodular areas with different attenuation patterns (long arrow). Intra lesional arterioportal shunting is noted (arrowhead). (b) Coronal maximum intensity projection (MIP) reconstruction demonstrates additional smaller satellite hypervascular lesions (short arrows)

(www.ajronline.org/27/9/2014 at 5:00pm)

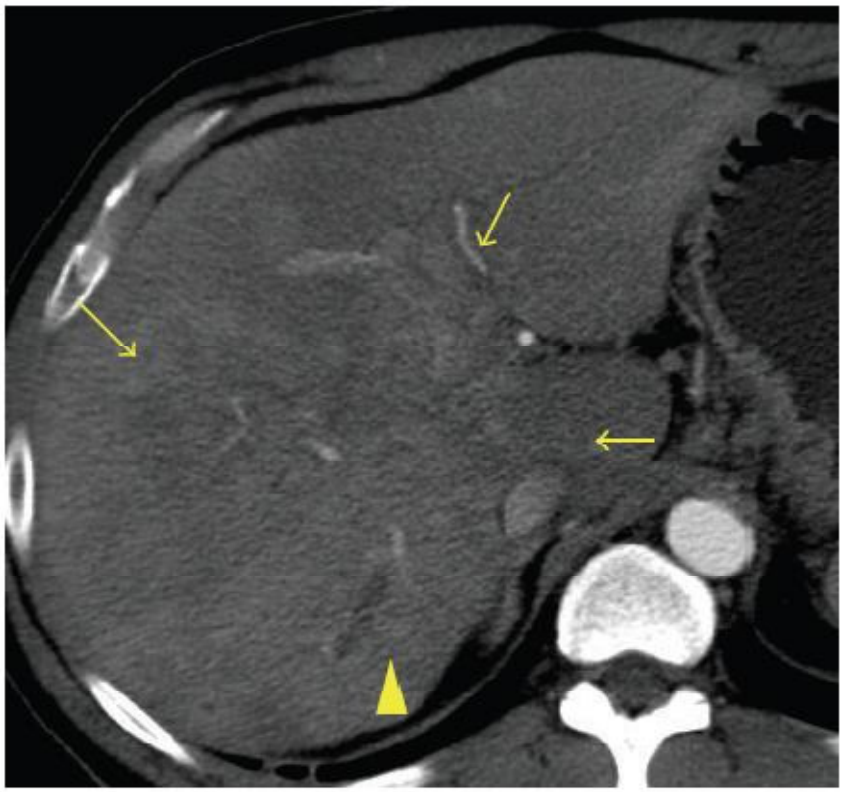


Fig 2-18: Diffuse hepatocellular carcinoma. Arterial-phase contrast enhanced axial CT scan demonstrates a large ill-defined heterogeneous mass occupying the right hepatic lobe (arrows). Focal intrahepatic biliary dilatation is seen (arrowhead). (www.ajronline.org/27/9/2014 at 5:00pm)

A triple phase evaluation of the liver with CT is essential to detect small HCCs. The recognition of the extra hepatic abdominal complications is vital for adequate clinical assessment and treatment. (Brookline Ave (2011).

2-4 CT imaging

2-4-1 Characterization and detection of focal liver lesions by MDCT

The vast majority of hemangiomas show a typical peripheral nodular enhancement pattern on relative-enhancement image from hepatic arterial

phase and persistent fill-in of the entire lesion over time on relative enhancement image from hepatic delayed phase. Characteristically, liver adenomas show a transient blush on the relative-enhancement image from hepatic arterial phase, and fade to iso-attenuation on the relative enhancement image from hepatic delayed phase. In case of previous hemorrhage, adenoma can be inhomogeneous on the relative-enhancement image from hepatic arterial phase. (Pandharipande et al (2005).

Typically, focal nodular hyperplasia (FNH) shows very intense homogeneous enhancement on the relative-enhancement image from hepatic arterial phase and iso-attenuation on the relative-enhancement image from hepatic delayed phase. The central scar of FNH is enhanced on the relative-enhancement image from hepatic delayed phase. Dysplastic nodules, especially high-grade dysplastic nodules, are premalignant lesions that can demonstrate enhancement on the relative-enhancement image from hepatic arterial phase. HCC (also called malignant hepatoma) . (Pandharipande et al (2005).

typically shows intense and early enhancement on wash-in rate, and relative-enhancement image from hepatic arterial phase, and much of the contrast lost on wash-out rate or relative-enhancement image from hepatic delayed phases. . (Pandharipande et al (2005).

In hepatic delayed phases, many HCCs show enhancement of a tumor capsule. (Pandharipande et al (2005).

The degree of enhancement of hypovascular liver metastases can be similar to the surrounding liver on the relative-enhancement image from hepatic arterial phase, but hypovascular liver metastases typically show lower enhancements than the surrounding liver and often show a

peripheral irregular ring of enhancement on the relative-enhancement image from hepatic portal phases. The periphery of liver metastases often has a higher wash-in rate than the center of the lesion on imaging. Hypovascular liver metastases shows slightly delayed enhancement, and the liver lost some of its contrast (Wang etal.(2008).

Cystic liver lesions, or fluid-containing lesions of the liver, are commonly encountered findings on radiologic examinations that may represent a broad spectrum of entities ranging from benign developmental cysts to malignant neoplasms. The wide range of pathologic processes that may result in cystic liver lesions can present a difficult diagnostic conundrum. The radiologist must carefully assess such imaging features as location, size, and unifocal or multifocal nature of the cyst or cysts as well as evaluate cyst complexity and associated findings. In addition, because radiologic features of various cystic liver lesions overlap, it is necessary to integrate imaging with clinical and laboratory findings to allow more definitive diagnosis.(Brookline (2011).

An important first step in narrowing the differential diagnosis is to determine the presence or absence of complex features in cystic liver lesions. To this end, fluid-containing liver lesions can be grouped broadly into simple or complex cysts.(Behroze,etal. (2012).

2-4-2triphasic liver protocol

2-4-2-1 patient preparation

After an overnight fast, the patients were asked to lie down for 1 hr before the CT examination to minimize physiologic variations in portal flow .CT

examinations were obtained with 16- or 64- MDCT scanners (Asteion, Aquilion, Japan manufactures).Patient preparation also included administration of 2000 ml of water/gastrografin 30- 60 minutes prior to the examination. (www.stmarysathens.org/2\12/2014 at 6:17 Pm)

Fig 2-19 Toshiba Aquilion 64 CT scanner

(www.stmarysathens.org/2\12/2014 at 6:17 Pm)

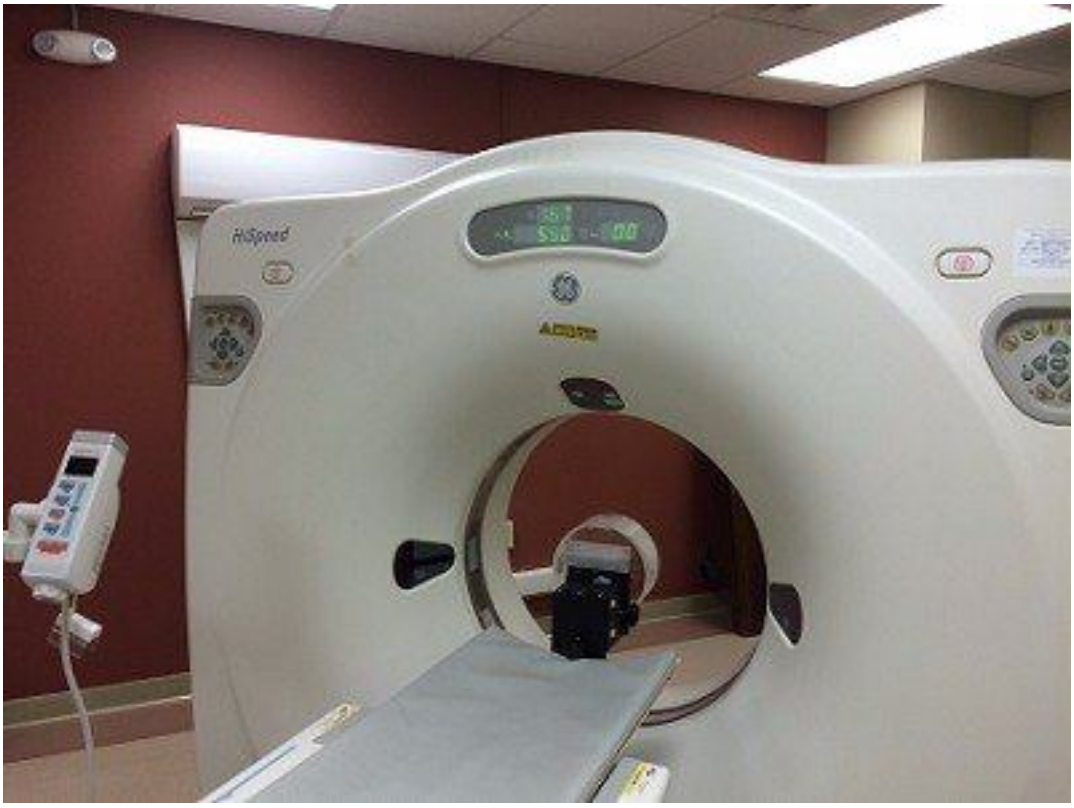


Fig 2-20 Dual slice MDCT with automatic injector

(http://www.anatolia.international/products / 1/1/2015 at 4:33 Pm)

2-4-2-2 Diagnostic criteria of liver diseases

CT examination protocols have been constant at which during the period of this study and included the following scan parameters: for the 16- MDCT scanner, we used 16 × 1.5 mm collimation, 2-mm slice thickness, 1-mm scan interval, 120 KVp, and 250 MAS. For the 64-MDCT scanner, used 64 × 0.625 mm collimation, 0.9-mm slice thickness, 0.45-mm slice interval, 120 KVp, and 300 MAS. In all cases, 3-mm-thick axial slices were reconstructed and sent to PACS. For the contrast enhanced portions of the examinations, most patients received with automatic injection using 75 ml omnipaque contrast media for adult with flow rate is 3.5ml/sec was administered IV through a 16- or 18-gauge catheter into an antecubital vein.

The scan begins immediately 5 mm /slice thickness then the reconstruction algorithm take 2.5mm. To avoid respiratory motion artifacts, patients were clearly informed of a possible flushing sensation during contrast agent injection.

The delay time for arterial phase images was determined by using bolus-tracking techniques with the tracker placed on the abdominal aorta at the level of the portal vein confluence and the activation threshold set at 150 HU with a further scan delay of 12 seconds after threshold. The delay times for portal venous phase and delayed phase were 70 seconds and 3 minutes after initiation of contrast infusion, respectively.

Enhancement of each lesion in each phase was evaluated, and the lesions were tabulated according to hyper enhancement, hypo enhancement, iso-dense to liver parenchyma and mixed enhancement pattern.

On the basis of triphasic CT scan findings, lesions were categorized as benign and malignant lesions. Benign lesions like hepatic cysts appear hypodense and have no enhancement in arterial, portovenous phase and equilibrium phases. Haemangioma showed peripheral enhancement in arterial phase and centripetal filling of contrast in portovenous and equilibrium phase. Focal nodular hyperplasia and hepatic adenoma have pattern of hyper enhancement, mixed and mixed on arterial, portovenous and equilibrium phases respectively. Hepatomas also have hyper enhancement, iso/mixed enhancement and iso/mixed enhancing pattern in arterial, portovenous and equilibrium phases respectively.

Hypervascular metastasis appears hyper enhancing on arterial phase with mixed pattern on portovenous and equilibrium phase. However, hypovascular metastasis appears hypoenhancing on arterial phase and shows

maximum enhancement on portovenous phase. History and clinical presentation were also considered for diagnosis.

The diagrams bellow shown time –attenuation curve for hypovascular lesion and hypervascular lesion the vertical line shown HU(Hounsfield unit)and the horizontal line shown sec(time)from injection of contrast media.

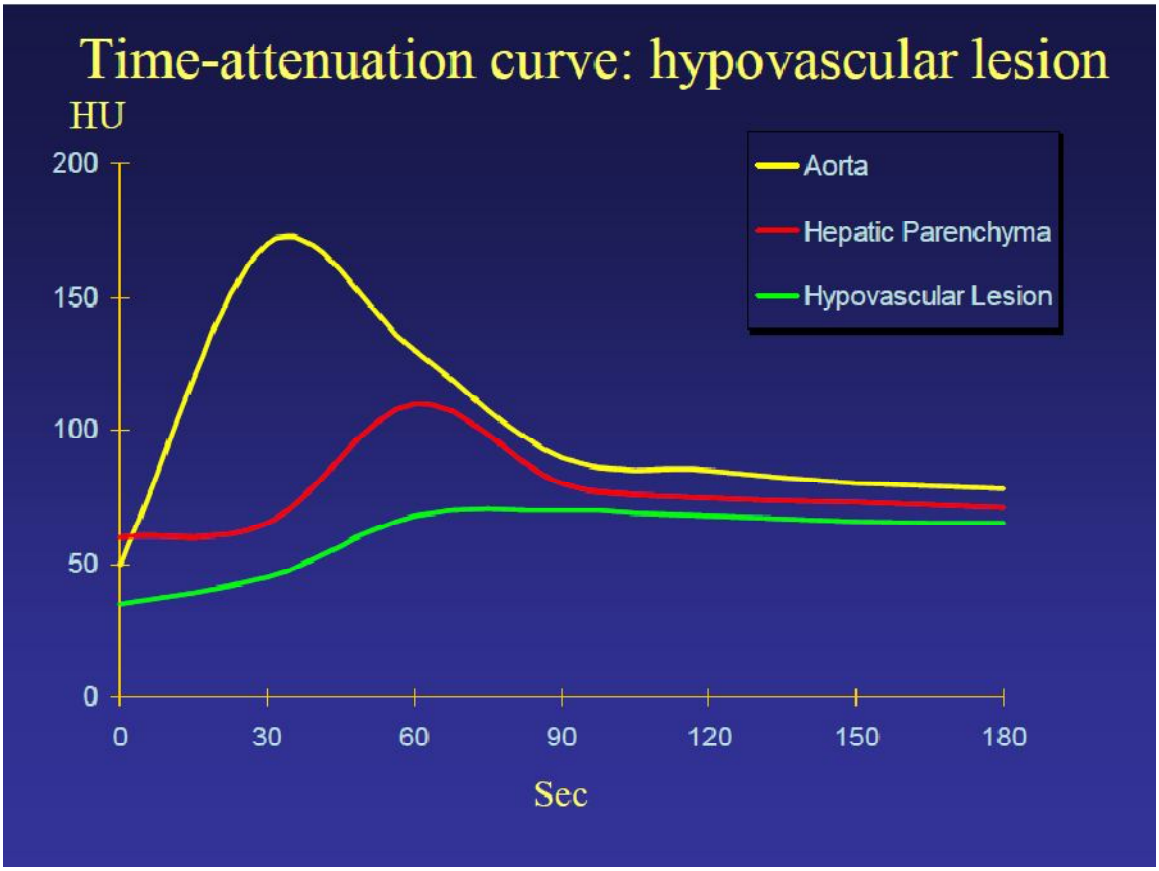


Fig 2-21 time –attenuation curve for hypovascular lesion (Jorge and Soto Boston university .Radiology2002)

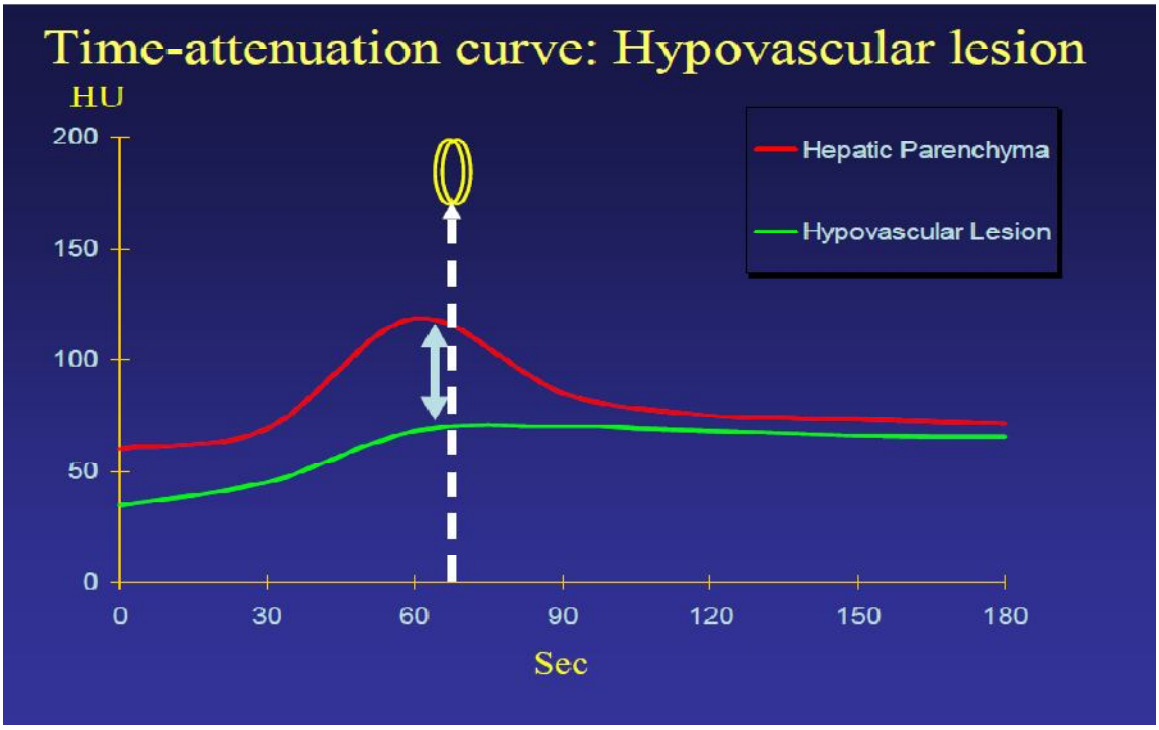


Fig 2-22 show time –attenuation curve for hypovascular lesion (Jorge and Soto Boston university .Radiology2002)

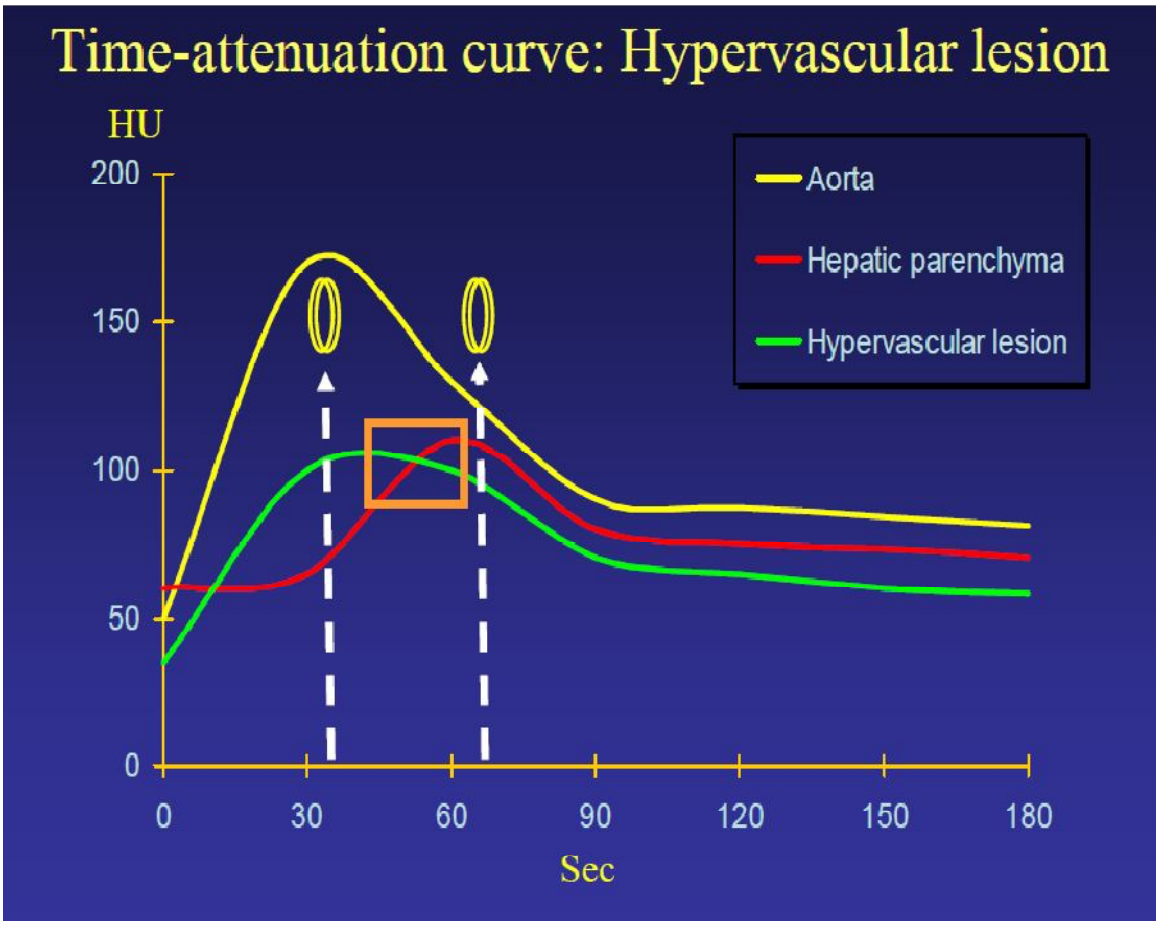


fig 2-23 show time –attenuation curve for hypervascular lesion (Jorge and Soto Boston university .Radiology2002)

2-4-2-3 Differentiation of focal liver lesion in triphasic protocol

In the arterial phase hypervascular tumors will enhance via the hepatic artery, when normal liver parenchyma does not yet enhances, because contrast is not yet in the portal venous system. These hypervascular tumors will be visible as hyperdense lesions in a relatively hypodense liver . (Jorge A. and Soto ,MD ,Boston university .Radiology)

However when the surrounding liver parenchyma starts to enhance in the portal venous phase, these hypervascular lesion may become obscured.

In the portal venous phase hypovascular tumors are detected, when the normal liver parenchyma enhances maximally. These hypovascular tumors will be visible as hypodense lesions in a relatively hyperdense liver.

In the equilibrium phase at about 10 minutes after contrast injection, tumors become visible, that either loose their contrast slower than normal liver, or wash out their contrast faster than normal liver parenchyma. These lesions will become either relatively hyperdense or hypodense to the normal liver. (Jorge and Soto Boston university .Radiology2002)

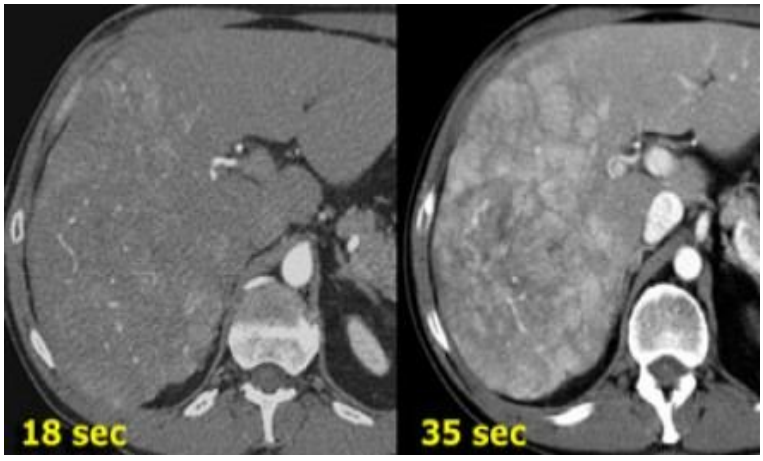
- 

Fig 2-24 CT of the liver in the early arterial phase (left) and the late arterial phase (right). (Jorge and Soto Boston university .Radiology2002)

Arterial phase imaging Optimal timing and speed of contrast injection are very important for good arterial phase imaging.

Hypervascular tumors will enhance optimally at 35 sec after contrast injection (late arterial phase). (Jorge and Soto Boston university .Radiology2002)

This time is needed for the contrast to get from the peripheral vein to the hepatic artery and to diffuse into the liver tumor.

On the fig 2-24 a patient who underwent two phases of arterial imaging at 18 and 35 seconds. In the early arterial phase the arteries we nicely see , but only see some irregular enhancement within the liver.

In the late arterial phase multiple tumor masses clearly identify.

Notice that in the late arterial phase there has to be some enhancement of the portal vein .

The only time that an early arterial phase is needed is when you need an arteriogram, for instance as a roadmap for chemoembolization of a liver tumor. (Jorge and Soto ,Boston university .Radiology(2002)

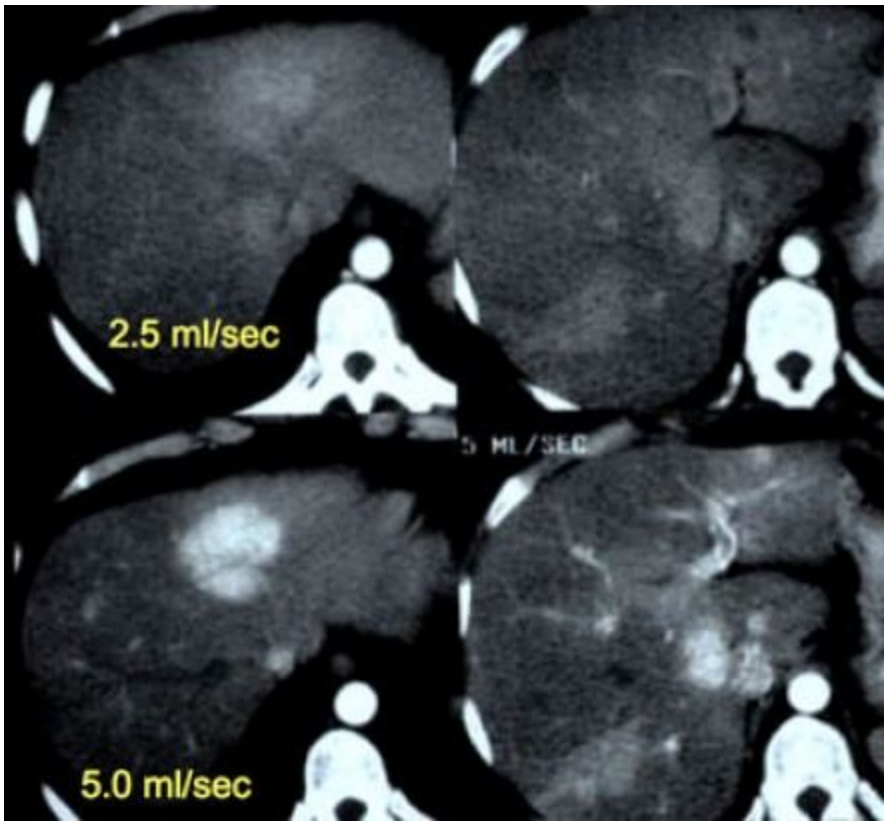
- 

Fig 2-25 Patient with liver cirrhosis and multifocal HCC injected at 2.5ml/sec (left) and at 5ml/sec (right). (Jorge A. and Soto ,MD ,Boston university .Radiology)

Timing of scanning is important, but almost as important is speed of contrast injection. (Jorge and Soto Boston university .Radiology2002)
For arterial phase imaging the best results are with an injection rate of 5ml/sec. There are two reasons for this better enhancement: at 5ml/sec there will be more contrast delivered to the liver when you start scanning and this contrast arrives in a higher concentration. (Jorge and Soto Boston university .Radiology2002)

The a patient with cirrhosis examined after contrast injection at 2.5ml/sec and at 5ml/sec. At 5ml/sec there is far better contrast enhancement and better tumor detection. (Jorge and Soto Boston university .Radiology2002)

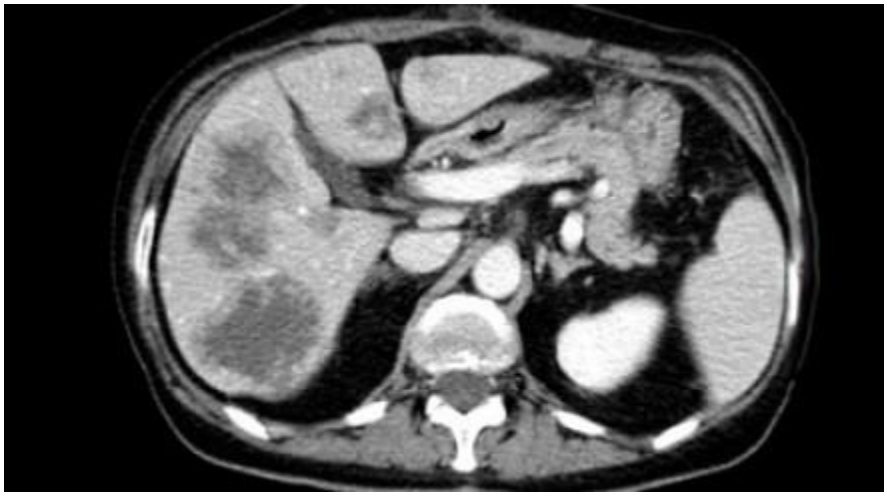
- 

Fig 2-26 Hypovascular metastases seen as hypodense lesions in the late portal venous phase. Notice some rim enhancement of the more viable peripheral areas of the metastases. *(Jorge and Soto Boston university .Radiology2002)*

Portal Venous phase imaging works on the opposite idea. We image the liver when it is loaded with contrast through the portal vein to

detect hypovascular tumors. (Jorge and Soto Boston university .Radiology2002)

The best moment to start scanning is at about 75 seconds, so this is a late portal venous phase, because enhancement of the portal vein already starts at 35 sec in the late arterial phase. (Jorge and Soto Boston university .Radiology2002)

This late portal venous phase is also called the hepatic phase because there already must be enhancement of the hepatic veins. If you do not seen enhancement of the hepatic veins, you are too early. (Jorge and Soto Boston university .Radiology2002)

If you only do portal venous imaging, for instance if you are only looking for hypovascular metastases in colorectal cancer, fast contrast injection is not needed, because in this phase the total amount of contrast is more important and 3ml/sec will be sufficient

Equilibrium Phase is when contrast is moving away from the liver and the liver starts to decrease in density. (Jorge and Soto Boston university .Radiology2002)

This phase begins at about 3-4 minutes after contrast injection and imaging is best done at 10 minutes after contrast injection.

This phase can be valuable if you're looking for: fast tumor washout in hypervascular tumors like HCC or retention of contrast in the blood pool as in hemangiomas or the retention of contrast in fibrous tissue in capsules (HCC) or scar tissue (FNH, Cholangioca).

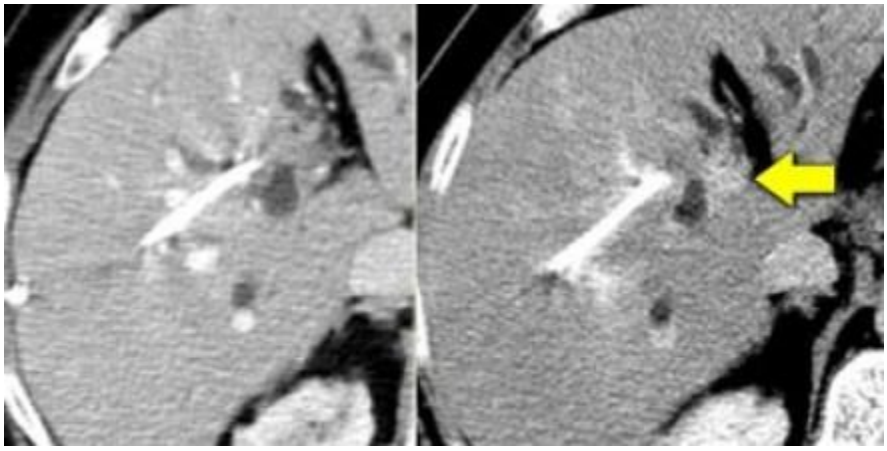
- 

Fig 2-27 Small cholangiocarcinoma not visible in portal venous phase (left), but seen as relative hyperdense lesion in the delayed phase (right). (Jorge and Soto Boston university .Radiology2002)

2-5 other liver imaging modalities for liver scanning

Imaging is essential for accurately diagnosing biliary tract disorders and is important for detecting focal liver lesions (eg, abscess, tumor). It is limited in detecting and diagnosing diffuse hepatocellular disease (eg, hepatitis, cirrhosis). (Nicholas and Orfanidis July 2013, American Journal of Roentgenology)

2-5-1 Ultrasonography

Ultrasonography, traditionally done transabdominally and requiring a period of fasting, provides structural, but not functional, information. It is the least expensive, safest, and most sensitive technique for imaging the biliary system, especially the gallbladder. Ultrasonography is the procedure of choice for screening for biliary tract abnormalities , evaluating the hepatobiliary tract in patients with right upper quadrant abdominal pain , differentiating intrahepatic from extrahepatic causes of jaundice and

detecting liver masses. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology)

Focal liver lesions > 1 cm in diameter can usually be detected by transabdominal ultrasonography. In general, cysts are echo-free; solid lesions (eg, tumors, abscesses) tend to be echogenic. Carcinoma appears as a nonspecific solid mass. Ultrasonography has been used to screen for hepatocellular carcinoma in patients at high risk (eg, with chronic hepatitis B, cirrhosis, or hemochromatosis). Because ultrasonography can localize focal lesions, it can be used to guide aspiration and biopsy.

Diffuse disorders (eg, cirrhosis, sometimes fatty liver) can be detected with ultrasonography. Ultrasound elastography can measure liver stiffness as an index of hepatic fibrosis. In this procedure, the transducer emits a vibration that induces an elastic shear wave. The rate at which the wave is propagated through the liver is measured; liver stiffness speeds this propagation. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology)

2-5-2 Doppler ultrasonography

This noninvasive method is used to assess direction of blood flow and patency of blood vessels around the liver, particularly the portal vein. Clinical uses include

Detecting portal hypertension, (eg, indicated by significant collateral flow and the direction of flow)

Assessing the patency of liver shunts (eg, surgical portocaval, percutaneous transhepatic).

Evaluating portal vein patency before liver transplantation and detecting hepatic artery thrombosis after transplantation.

Detecting unusual vascular structures (eg, cavernous transformation of the portal vein) and assessing tumor vascularity before surgery. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology)

2-5-3 Radionuclide liver scanning

Ultrasonography and CT have largely supplanted radionuclide scanning, which had been used to diagnose diffuse liver disorders and mass lesions of the liver. Radionuclide scanning shows the distribution of an injected radioactive tracer, usually technetium (^{99m}Tc sulfur colloid), which distributes uniformly within the normal liver. Space-occupying lesions > 4 cm, such as liver cysts, abscesses, metastases, and tumors, appear as defects. Diffuse liver disorders (eg, cirrhosis, hepatitis) decrease liver uptake of the tracer, with more appearing in the spleen and bone marrow. In hepatic vein obstruction (Budd-Chiari syndrome), liver uptake is decreased except in the caudate lobe because its drainage into the inferior vena cava is preserved. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

2-5-4 Plain x-ray of the abdomen

Plain x-rays are not usually useful for diagnosis of hepatobiliary disorders. They are insensitive for gallstones unless the gallstones are calcified and large. Plain x-rays can detect a calcified (porcelain) gallbladder. Rarely, in gravely ill patients, x-rays show air in the biliary tree, which suggests emphysematous cholangitis. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

2-5-5 MRI

MRI is used to image blood vessels (without using contrast), ducts, and hepatic tissues. Its clinical uses are still evolving. MRI is superior to CT and ultrasonography for diagnosing diffuse liver disorders (eg, fatty liver, hemochromatosis) and for clarifying some focal defects (eg, hemangiomas). MRI also shows blood flow and therefore complements Doppler ultrasonography and CT angiography in the diagnosis of vascular abnormalities and in vascular mapping before liver transplantation. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

Magnetic resonance cholangiopancreatography (MRCP) is more sensitive than CT or ultrasonography in diagnosing common bile duct abnormalities, particularly stones. Its images of the biliary system and pancreatic ducts are comparable to those obtained with ERCP and percutaneous transhepatic cholangiography, which are more invasive. Thus, MRCP is a useful screening tool when biliary obstruction is suspected and before therapeutic ERCP (eg, for simultaneous imaging and stone removal) is done. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

2-5-6 ERCP

ERCP combines endoscopy through the second portion of the duodenum with contrast imaging of the biliary and pancreatic ducts. The papilla of Vater is cannulated through an endoscope placed in the descending duodenum, and the pancreatic and biliary ducts are then injected with a contrast agent. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

ERCP provides detailed images of much of the upper GI tract and the periampullary area, biliary tract, and pancreas. ERCP can also be used to obtain tissue for biopsy. ERCP is the best test for diagnosis of ampullary cancers. ERCP is as accurate as endoscopic ultrasonography for diagnosis of common duct stones. Because it is invasive, ERCP is used more for treatment (including simultaneous diagnosis and treatment) than for diagnosis alone. ERCP is the procedure of choice for treating biliary and pancreatic obstructing lesions, as for removal of bile duct stones, stenting of strictures (inflammatory or malignant) and sphincterotomy (eg, for sphincter of Oddi dysfunction). (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

Morbidity from a diagnostic ERCP with only injection of contrast material is about 1%. Adding sphincterotomy raises morbidity to 4 to 9% (mainly due to pancreatitis and bleeding). ERCP with manometry to measure sphincter of Oddi pressure causes pancreatitis in up to 25% of patients. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

2-5-7 Percutaneoustranshepatic cholangiography (PTC)

With fluoroscopic or ultrasound guidance, the liver is punctured with a needle, the peripheral intrahepatic bile duct system is cannulated above the common hepatic duct, and a contrast agent is injected.

PTC is highly accurate in diagnosing biliary disorders and can be therapeutic (eg, decompression of the biliary system, insertion of an endoprosthesis). However, ERCP is usually preferred because PTC causes more complications (eg, sepsis, bleeding, bile leaks). (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

2-5-8 Operative cholangiography

A contrast agent is directly injected during laparotomy to image the bile duct system.Operative cholangiography is indicated when jaundice occurs and noninvasive procedures are equivocal, suggesting common duct stones. The procedure can be followed by common duct exploration for removal of biliary stones. Technical difficulties have limited its use, particularly during laparoscopic cholecystectomy. (Nicholas and Orfanidis July 2013, American Journal of Roentgenology).

2-6 previous study

Hafeez(2011)had study Triphasic computed tomography (CT) scan in focal tumoral liver lesions **.**The study was conducted in Department of Radiology of Aga Khan University Hospital and Sind

Institute of Urology and Transplantation, Karachi from Feb 2006 to Feb 2007. By convenient sampling, 45patients found to have focal tumoral liver lesions were recruited for one year period and their triphasic CT scans findings were evaluated and later correlated with histopathology. Sensitivity, specificity, positive predictive value,negative predictive value and diagnostic accuracy of triphasic CT scan were calculated. The results was Among 45 patients, 136 liver lesions (11 benign and 125 malignant) were detected with the help of different enhancement patterns. Out of these, 37(82.2%) patients had malignant while 8 (17.8%) had benign

lesions. On later histopathological examination, 35 (77.8%) of the total 45 cases had malignant lesions while 10(22.2%) were diagnosed as benign lesions. Based on these results, it could be assessed that triphasic CT Scan

has a sensitivity of 100 %, specificity of 80%, positive predictive value of 94.5%, negative predictive value of100% and diagnostic accuracy of 95.5 % in differentiating benign from malignant liver lesions.

Martens and vanleeuwen, (1993) had study focal liver lesions: characterization with triphasic spiral CT the study was one hundred five patients with suspected focal liver disease underwent triphasic liver CT. After injection of contrast material, the liver was scanned in arterial (scanning delay, 22-27 seconds), portal (scanning delay, 49-73 seconds), and equilibrium (scanning delay, 8-10 minutes) phases. Enhancement of each lesion in each phase was evaluated, and the lesions were tabulated according to one of 11 enhancement patterns.

In 94 patients, 375 liver lesions were detected. The nature ofthe lesion was confirmed in 326 lesions (87%). Six of 11 enhancement patterns were always due to benign disease and caused by areas with hyper- or hypo perfusion, hemangiomas, cysts, focal nodular hyperplasias, or benign but non specified lesions. Two of 11 patterns were always due to malignant disease, and one pattern was due to malignant disease in 38 (97%) of 39 patients with known malignancy else where or with chronic liver disease. The other two patterns were seen in metastases and partly fibrosed hemangiomas.

Minami kogushi**,** (2004) study Hepatic Enhancement in Multiphasic Contrast-Enhanced MDCT and the effect of contrast: Comparison of High- and Low-Iodine- Concentration Contrast Medium in Same Patients with Chronic Liver Disease

The study included 20 patients with chronic liver diseases who underwent at least two multiphasic contrast-enhanced dynamic MDCT examinations using

100 mL of standard (300 mg I/mL = group A) and higher (370 mg I/mL = group B) iodine concentrations in contrast medium. After we obtained unenhanced CT scans, we performed multiphasic scanning at 30 sec (arterial phase), 60 sec (portal phase), and 180 sec (late phase) after the start of contrast medium injection. The CT values of hepatic parenchyma, abdominal aorta, and portal vein were measured. The mean enhancement value was defined as the difference in CT and values between unenhanced and contrast-enhanced images. Visual image quality was also assessed on the basis of the degree of hepatic and vascular enhancement, rated on a 4-point scale.

The mean hepatic parenchyma enhancement values in group B was significantly greater ($p < 0.001$) than those in group A during the portal phase (43.8 ± 8.2 H vs 36.2 ± 7.3 H) and the late phase (33.7 ± 7.0 H vs 27.3 ± 3.9 H), but the difference on the arterial phase images between the two groups (9.4 ± 3.2 H vs 8.3 ± 2.5 H) was not significant. The mean aorta-to-liver contrast during the arterial phase in group B was significantly higher ($p < 0.001$) than that in group A (236 ± 40 H vs 193 ± 32 H). For qualitative analysis, the mean visual scores for hepatic parenchyma and vasculature enhancement in group B were significantly higher than those in group A in arterial phase ($p < 0.018$), portal phase ($p < 0.0001$), and late phase ($p < 0.0001$).

Liang Wang ,(2010) study Morphological and functional MDCT: problemsolving tool and surrogate biomarker for hepatic disease clinical care and drug discovery in the era of personalized medicine

his study explains the significant role of morphological and functional multidetector computer tomography (MDCT) in combination with imaging postprocessing algorithms served as a problem-solving tool and noninvasive

surrogate biomarker to effectively improve hepatic diseases characterization, detection, tumor staging and prognosis, therapy response assessment, and novel drug discovery programs, partial liver resection and transplantation, and MDCT guided interventions in the era of personalized medicine. State-of-the-art MDCT depicts and quantifies hepatic disease over conventional CT for not only depicting lesion location, size, and extent but also detecting changes in tumor biologic behavior caused by therapy or tumor progression before morphologic changes.

Reported sensitivity of MDCT varies widely, with values of 6%–89% for the detection of HCC.57,58 Relatively high sensitivity (74%–85%) for metastatic liver tumors has been reported.58 Primary and metastatic liver malignancies and cirrhosis can be earlier detected based on relative increases in HBF. Diagnostic sensitivity and accuracy of MDCT are significantly improved and result in better detection of hepatic lesions, thus decreasing the number of biopsies Evaluation of diffuse liver disease and hepatic perfusion disorder Diffuse liver parenchymal diseases consist of various disease processes, such as cirrhosis, infectious and inflammatory diseases, storage diseases, vascular diseases, and diffuse malignancies.59 Significant changes in perfusion parameters(arterial blood flow (ABF), blood volume (BV), mean transit time (MTT), portal blood flow (PBF), total blood flow (TBF)) (increased ABF/BV/MTT, and decreased PBF/TBF) were observed in cirrhosis as a result of excessive deposition of collagen in the space of Disse and defenestration of the basal lamina, sinusoids.22,23,60–62 Moreover, the changes in the perfusion parameters correlated with the severity (the degree of fibrosis) of chronic liver disease. Acute hepatitis may present with heterogeneous patchy enhancement of the affected liver parenchyma in hepatic arterial phase and becomes occult in hepatic portal

and delayed phases. MDCT have been applied to evaluate hepatic functional reserve and liver volume variation in patients with chronic liver diseases.63–64 Hepatic perfusion disorders are related to a variety of disease entities or anatomic variants, such as portal venous obstruction,

arterial obstruction, hepatic venous obstruction (eg, Budd–Chiari syndrome, heart failure, mediastinal fibrosis), mediastinal or thoracic venous inlet obstruction, focal liver lesions, inflammatory processes, normal anatomic variants in the hepatic blood supply, altered hemodynamics after the placement of a transjugular intrahepatic portosystemic shunt, and uncertain causes.

Yuji etal (1983) comparative study between CT and US in characterization of liver lesion specially heamngioma In 35 of 38 lesions examined by CT before and after bolus contrast enhancement, findings were dense contrast enhancement spreading in all directions on subsequent scans and/or density (other than capsule or septa) higher than normal hepatic parenchyma after 2 mm. Lesions smaller than 1 cm were not detected. Misregistration in sequential scans prevented diagnosis of three of nine lesions smaller than 2 cm. Sonography revealed various patterns of mass, but in the smaller lesions, an extremely hyperechoic pattern was dominant. The contributions of CT and sonography depend on the size of the lesions.

CHAPTER THREE

Chapter three

Materials and Methods

3-1 Area and duration

This study was prospective study done in Khartoum state during the period from February 2014 to December 2016 at Alfaisal Specialized Hospital, Ibn alhaitham Diagnostic Centre, Antalya Medical Centre and Royal Care International Hospital.

3-2 Materials

3-2-1 Patients

100 consecutive Sudanese patients (51 male and 49 female) age range between 10-95 years . All patients with suspected liver disease were included in the study and patients with normal liver are excluded from study abdominal US was done firstly followed by Triphasic CT scan for the liver .

3-2-2 Machine

The study was simultaneously conducted in Department of Diagnostic Radiology in CT department. MDCT machine in Alfaisal Specialized Hospital was Toshiba 4 slice (Asteion) , Royal Care International Hospital, the CT machine Toshiba 64 slice (Aquilion), Ibnalhaitham Diagnostic Centre, the CT machine Toshiba 4 slice (Japan manufactures) and In Antalya Medical Centre, the CT machine bride speed 8 slice (American manufactures).

3-3 Methods

3-3-1 Method of triphasic CT scan protocol

All machine used 120 KVP, 200 MAS ,also used triphasic protocol firstly done scout view(coronal section)then take plain film without CM ,then begin the scan early arterial phase (20 sec from injection), venous phase (portovenous phase 40 sec) and delayed phase (5-10min) with automatic injection 70-100 ml omnipaque contrast media flow rate is 4ml/sec,and using 18gague needle for injection . the oral CM 500ml in 3water bottle each one have 10ml of CM. Slice thickness 5mm/slice, the reconstruction algorithm take 2.5mm.

3-3-2 Technique

Patient position is supine position feet first, the longutiduanl alignment line with the patient mid line and the transverse line at the Xiphoid process. The scans begin from Xiphoid process to symphysis pubis.

3-3-3 Method of image interpretation

The data collected using the following variables :age ,gender, clinical finding , lab finding (if founded),US finding and features.

To characterize the liver and liver disease were taken as follow:

-liver texture: is the surface of the liver either have a homogenous texture or a heterogonous one.

- Lesion CT No: is the CT number of liver lesion founded on a image and were measured by HU (Hounsfield unit).

-Lesion out line : is the border of lesion either to be regular out line or irregular border.

-No of lesion: number of lesion in the CT image (1,2,3 or multiple lesion (more than three)).

- Constitution of lesion: is the lesion contents(fluids, gas, soft tissue mass ,or mixed).

- Site of lesion :is where the lesion located in the liver (RT lobe,LTlobe,caudate lobe)also the lesion can located in more than one lobe.

- Size of lesion: is measurement the lesion size in (cm)

- Characterization of lesion: is the characterization of lesion by CT , it can be hypodense lesion or hyperdense lesion or isodense lesion .

-C.M used : is the contrast media used .if were using oral contrast media ,intravenous contrast media or both .also in some situation rectal contrast media were used.

-enhancement of contrast: is triphasic contras protocol used for liver and enhancement of lesion in each phase (arterial phase ,venous phase ,delay phase).

--In the arterial phase show the early enhance of lesion or non enhance of lesion .

--In the portal venous phase show if the lesion enhance in the portovenous phase or non enhance

--In the delay phase show if the still having enhance or non having it.

-interaction of lesion with the C.M : is position of contrast in lesion and in each phase was the contrast found in the lesion or are washed out or lesion were empty of contrast.

-CT report : is the CT diagnosis of each patients showing each liver disease were reported (cyst ,homongioma ,cirrhosis, HCC, metastases …..etc) by Radiologist.

3-3-4 statistical analysis

The data obtained were analysized statisticaly by computing descriptive statistic like Mean values and percentage , ANOVA test was applied to test the significance of differences, p-value of less than 0.05 was considered to be statistically significant and by correlation analysis using an IBM SPSS statistic software package (Inc.,Chicago,Illinois version 16).

CHAPTER FOUR

Chapter four

Result

Table 4-1: CT Findings (Diagnosis) In all of the examined cases, frequency and percentages

CT (diagnosis)	Frequency	Percentages (%)
Cirrhosis +Liver Metastases	1	2.0
Calcified Granuloma +Liver Metastases	1	2.0
Calcified Granuloma+ Liver Abscess	1	2.0
Cirrhosis	4	8.0
Cirrhosis + Liver Tumor	5	10.0
Hemangioma	8	16.0
Hepatic Tumor	2	4.0
Hepatic Tumor + Liver Metastases	1	2.0
Hepatoma	2	4.0
Hepato-splenomegaly	4	8.0
Hepato-splenomegaly + Hepatitis	1	2.0
Hydatic Cyst	2	4.0
Liver Abscess	1	2.0
Liver Metastases	9	18.0
Lymphoma	1	2.0
Simple Cyst	6	12.0
Simple Cyst + Cirrhosis	1	2.0
Total	50	100.0

Table 4-2: Type of liver disease of examined cases and frequency

Liver disease	frequency
Cirrhosis	11
Liver Metastases	12
Calcified Granuloma	2
Liver Abscess	2
Liver Tumor	5
Hemangioma	8
Hepatic Tumor	3
Hepatoma	2
Hepato-splenomegaly	5
hepatitis	1
Hydatic Cyst	2
lymphoma	1
Simple Cyst	7

Table 4-3: Cross tabulation between the CT (diagnosis) and liver texture (Homogeneous and Heterogeneous)

		liver texture		Total
		Heterogeneous	Homogenous	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	4	0	4
		8.0%	.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	5
		10.0%	.0%	10.0%
	Hemangioma	1	7	8
		2.0%	14.0%	16.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	1	1	2
		2.0%	2.0%	4.0%
	Hepatosplenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	1	0	1
		2.0%	.0%	2.0%
	Liver Metastases	9	0	9
		18.0%	.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	1	0	1
		2.0%	.0%	2.0%
Total		27	23	50
		54.0%	46.0%	100.0%
Correlations		*P-value= 0.059*		

Table 4-4 :Cross tabulation between the CT (diagnosis) and lesion out line

		lesion Out Line		Total
		Irregular	Regular	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Heamangioma	0	8	8
		.0%	16.0%	16.0%
	Calcified Granuloma +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	4	0	4
		8.0%	.0%	8.0%
	Cirrhosis + Hepatic Tumor	5	0	5
		10.0%	.0%	10.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepatosplenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	1	0	1
		2.0%	.0%	2.0%
	Liver Metastases	9	0	9
		18.0%	.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		24	26	50
		48.0%	52.0%	100.0%
Correlations		*P-value= 0.000*		

Table 4-5 :Cross tabulation between the CT (diagnosis) and characterize of lesion (hyper attenuating, hypo attenuating)

		Characterize Of Lesion		Total
		Hyper attenuating	Hypo attenuating	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	1	3	4
		2.0%	6.0%	8.0%
	Cirrhosis + Liver Tumor	0	5	5
		.0%	10.0%	10.0%
	Hemangioma	0	8	8
		.0%	16.0%	16.0%
	Hepatic Tumor	0	2	2
		.0%	4.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepato-splenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Liver Metastases	0	9	9
		.0%	18.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		2	48	50
		4.0%	96.0%	100.0%
Correlations		*P=0.001*		

Table 4-6: Cross tabulation between the CT (diagnosis) and enhancement of the lesion at arterial phase

		Enhancement Arterial Phase			Total
		Early Enhance	Enhance	No Enhance	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Cirrhosis	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	4	1	0	5
		8.0%	2.0%	.0%	10.0%
	Hemangioma	0	8	0	8
		.0%	16.0%	.0%	16.0%
	Hepatic Tumor	1	1	0	2
		2.0%	2.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Hepatoma	0	2	0	2
		.0%	4.0%	.0%	4.0%
	Hepato-splenomegaly	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Hydatic Cyst	0	1	1	2
		.0%	2.0%	2.0%	4.0%
	Liver Abscess	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Liver Metastases	6	3	0	9
		12.0%	6.0%	.0%	18.0%
	Lymphoma	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Simple Cyst	0	0	6	6
		.0%	.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	0	1	1
		.0%	.0%	2.0%	2.0%
Total		13	19	18	50
		26.0%	38.0%	36.0%	100.0%
Correlations		*P-Value= 0.001*			

Table 4-7 :Cross tabulation between the CT (diagnosis) and enhancement of the lesion at Venous Phase

		Enhancement Venous Phase		Total
		Enhance	No Enhance	
CT report (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	0	4	4
		.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	5
		10.0%	0%	10.0%
	Hemangioma	8	0	8
		16.0%	0%	16.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	2	0	2
		4.0%	.0%	4.0%
	Hepato-splenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	1	1	2
		2.0%	2.0%	4.0%
	Liver Abscess	1	0	1
		2.0%	.0%	2.0%
	Liver Metastases	9	0	9
		18.0%	.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst – Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		30	20	50
		60.0%	40.0%	100.0%
Correlations		*P-Value= 0.001*		

Table 4-8 :Cross tabulation between the CT (diagnosis) and enhancement of the lesion at Delay Phase

		Enhancement At Delay Phase		Total
		Enhance	No Enhance	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	0	4	4
		.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	1	4	5
		2.0%	8.0%	10.0%
	Hemangioma	8	0	8
		16.0%	.0%	16.0%
	Hepatic Tumor	0	2	2
		.0%	4.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepato-splenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepato-splenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Liver Metastases	0	9	9
		.0%	18.0%	18.0%
	Lymphoma	0	1	1
		.0%	2.0%	2.0%
	Simple Cyst	0	6	6
		.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	1
		.0%	2.0%	2.0%
Total		9	41	50
		18.0%	82.0%	100.0 %
Correlations		*P-Value= 0.000*		

Table 4-9: Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at Arterial Phase

		Interaction At Arterial Phase				Total
		No Enhance	Peripheral homogeneous Enhance	Peripheral And Central Enhance	Peripheral Heterogeneous Enhance	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	0	0	1	1
		.0%	.0%	.0%	2.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	0	0	1
		.0%	.0%	.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	0	1
		.0%	2.0%	.0%	.0%	2.0%
	Cirrhosis	4	0	0	0	4
		8.0%	.0%	.0%	.0%	8.0%
	Cirrhosis + Liver Tumor	0	1	0	4	5
		.0%	2.0%	.0%	8.0%	10.0%
	Cyst	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
	Hemangioma	0	5	0	3	8
		.0%	10.0%	.0%	6.0%	16.0%
	Hepatic Tumor	0	0	1	1	2
		.0%	.0%	2.0%	2.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	0	0	1
		.0%	2.0%	.0%	.0%	2.0%
	Hepatoma	0	2	0	0	2
		.0%	4.0%	.0%	.0%	4.0%
	Hepato-Splenomegaly	4	0	0	0	4
		8.0%	.0%	.0%	.0%	8.0%
	Hepato-Splenomegaly + Hepatitis	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
	Hydatic Cyst	1	1	0	0	2
		2.0%	2.0%	.0%	.0%	4.0%
	Liver Abscess	0	0	1	0	1
		.0%	.0%	2.0%	.0%	2.0%
	Liver Metastases	0	4	0	5	9
		.0%	8.0%	.0%	10.0%	18.0%
	Lymphoma	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
	Simple Cyst	5	0	0	0	5
		10.0%	.0%	.0%	.0%	10.0%
	Simple Cyst + Cirrhosis	1	0	0	0	1
		2.0%	.0%	.0%	.0%	2.0%
Total		18	16	2	14	50
		36.0%	32.0%	4.0%	28.0%	100.0%
Correlations		*P-Value= 0.000*				

Table 4- 10: Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at venous Phase

		Interaction At Venous Phase			Total
		Late Enhance	No Enhance	Rapid Washout	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Calcified Granuloma +Liver metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Cirrhosis	0	4	0	4
		.0%	8.0%	.0%	8.0%
	Cirrhosis + Liver Tumor	0	0	5	5
		.0%	.0%	10.0%	10.0%
	Hemangioma	8	0	0	8
		16.0%	.0%	.0%	16.0%
	Hepatic Tumor	0	0	2	2
		.0%	.0%	4.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Hepatoma	2	0	0	2
		4.0%	.0%	.0%	4.0%
	Hepato-Splenomegaly	0	4	0	4
		.0%	8.0%	.0%	8.0%
	Hepato-Splenomegaly + Hepatitis	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Hydatic Cyst	0	2	0	2
		.0%	4.0%	.0%	4.0%
	Liver Abscess	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Liver Metastases	0	0	9	9
		.0%	.0%	18.0%	18.0%
	Lymphoma	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Simple Cyst	0	6	0	6
		.0%	12.0%	.0%	12.0%
	Simple Cyst + Cirrhosis	0	1	0	1
		.0%	2.0%	.0%	2.0%
Total		10	21	19	50
		20.0%	42.0%	38.0%	100.0%
Correlations		*P-value= 0.000*			

Table 4-11: Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at delay Phase

		Interaction Delay Phase			Total
		Empty	Filling	No Enhance	
CT report (diagnosis)	Cirrhosis +Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Calcified Granuloma +Liver metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Calcified Granuloma + Liver Abscess	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Cirrhosis	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	0	5
		10.0%	.0%	.0%	10.0%
	Hemangioma	0	8	0	8
		.0%	16.0%	.0%	16.0%
	Hepatic Tumor	2	0	0	2
		4.0%	.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Hepatoma	2	0	0	2
		4.0%	.0%	.0%	4.0%
	Hepatosplenomegaly	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Hydatic Cyst	1	0	1	2
		2.0%	.0%	2.0%	4.0%
	Liver Abscess	1	0	0	1
		2.0%	0%	0%	2.0%
	Liver Metastases	9	0	0	9
		18.0%	.0%	.0%	18.0%
	Lymphoma	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Simple Cyst	0	0	6	6
		.0%	.0%	12.0%	12.0%
	Simple Cyst + Cirrhosis	0	0	1	1
		.0%	.0%	2.0%	2.0%
Total		22	8	20	50
		44.0%	16.0%	40.0%	100.0%
Correlations		*P-value= 0.000*			

Table 4-12 .Shows The Ultrasound Scanning Results (Liver Lesions and Associated Findings) done for patients before the ct scanning

Diagnosis	**Frequency**	**Percentages %**
Abdomino Pelvic Mass + Bilateral Ovarian Dermoid Cysts	1	2.0
Ascites + Hepatic Lesion	24	48.0
Hepatic Lesion +Ca Prostate	1	2.0
Fatty Liver	1	2.0
Hepatocelluler carcinoma	1	2.0
Hepatic Lesion + Adnexal Mass	1	2.0
Hepatic Lesion + Heamoprotenium	1	2.0
Hepatic Lesion + Hepatosplenomegaly	3	6.0
Hepatic Lesion + Old TB Granuloma	1	2.0
Hepatic Lesion + Sigmoid Tumor	1	2.0
Hepatosplenomegaly + Portal Hypertension	1	2.0
Hydatid Liver Cyst	1	2.0
Liver Cyst	2	4.0
Liver Mass	2	4.0
Liver Metastases	1	2.0
Multiple Focal Sub-Diaphragmatic + Sub-Capsular Lesions+ Multiple Mesenteric and Para-Aortic Lymphadenopathies	3	6.0
Hepatic Lesion +Pancreatic Tumor	3	6.0
Liver Mass+ Right Inguinal Hernia	1	2.0
Hepatic Lesion+ Right Renal Stone	1	2.0
Total	50	100.0

Table 4-13. Shows the CT Scanning Results (Liver Lesions and Associated Findings)

	Frequency	**Percentages %**
Cyst	10	20.0
Cyst + Hepatitis	1	2.0
Haemangioma	7	14.0
Haemangioma + Old Calcified Granuloma	1	2.0
Hepatocelluler carcinoma	5	10.0
Hepatocelluler carcinoma + Liver Cirrhosis	4	8.0
Hepatosplenomegaly	1	2.0
Liver Abscess	3	6.0
Liver Cirrhosis	1	2.0
Liver Metastases	15	30.0
Liver Mets + Hepatosplenomegaly	1	2.0
Liver Metastases + Lymphoma	1	2.0
Total	50	100.0

Table 4-14 .Characterization of lesion contour by CT Scanning

	Frequency	**Percentages%**
Hypo dense non-enhancing focal lesions	15	30.0
Oval -shape hypo dense focal hepatic lesion	8	16.0
Rounded hypo dense focal hepatic lesion	27	54.0
Total	50	100.0

Table 4-15. Characterization of Lesion Enhancement by CT Scanning

	Frequency	**Percentages%**
Peripheral Nodular Enhancement	36	72.0
Non Enhance	14	28.0
Total	50	100.0

Table 4-16 .Enhancement patterns of the hepatic lesions cross tabulated with CT scanning diagnosis

CT (diagnosis)	Enhancement pattern		Total
	Non Enhance	Peripheral Nodular Enhancement	
Cyst	10	-	10
	20.0%	-	20.0%
Cyst + Hepatitis	1	-	1
	2.0%	-	2.0%
Haemangioma	-	7	7
	-	14.0%	14.0%
Haemangioma + Old Calcified Granuloma	-	1	1
	-	2.0%	2.0%
Hepatocelluler carcinoma	-	5	5
	-	10.0%	10.0%
Hepatocelluler carcinoma + Liver Cirrhosis	-	4	4
	-	8.0%	8.0%
Hepatosplenomegaly	1	-	1
	2.0%	-	2.0%
Liver Abscess	-	3	3
	-	6.0%	6.0%
Liver Cirrhosis	1	-	1
	2.0%	-	2.0%
Liver Metastases	1	15	15
	2.0%	30.0%	30.0%
Liver Metastases + Hepatosplenomegaly	-	1	1
	-	2.0%	2.0%
Liver Metastases + Lymphoma	-	1	1
	-	2.0%	2.0%
Total	14	36	50
	28.0%	72.0%	100.0%
P-value	0.001		

Table 4-17 .Characteristic Features of Detected Hepatic Lesions on CT cross tabulated with CT scanning diagnosis

CT Report (Diagnosis)	Lesion Characteristics			Total
	Hypo dense non-enhancing focal lesions	Oval -shape hypo dense focal hepatic lesion	Rounded hypo dense focal hepatic lesion	
Cyst	10	-	-	10
	20.0%	-	-	20.0%
Cyst + Hepatitis	1	-	-	1
	2.0%	-	-	2.0%
Haemangioma	-	6	2	8
	-	12.0%	4.0%	16.0%
Hepatocelluler Carcinoma	-	2	3	5
	-	4.0%	6.0%	10.0%
Hepatocelluler Carcinoma + Liver Cirrhosis	-	-	4	4
	-	-	8.0%	8.0%
Hepatosplenomegaly	1	-	-	1
	2.0%	-	-	2.0%
Liver Abscess	-	-	3	3
	-	-	6.0%	6.0%
Liver Cirrhosis	1	-	-	1
	2.0%	-	-	2.0%
Liver Metastases	2	-	13	15
	4.0%	-	26.0%	30.0%
Liver Metastases + Hepatosplenomegaly	-	-	1	1
	-	-	2.0%	2.0%
Liver Metastases + Lymphoma	-	-	1	1
	-	-	2.0%	2.0%
Total	15	8	27	50
	30.0%	16.0%	54.0%	100.0%
P-value	0.001			

Table 4-18. Ultrasonographic findings cross tabulated with CT scanning diagnosis

US Report (Diagnosis)	CT Report (Diagnosis)											Total
	Cyst	Cyst + Hepatitis	Haemangioma + Old Clacified Granuloma	HCC	HCC+ Liver Cirrhosis	Hepatosplenomegaly	Liver Abscess	Liver Cirrhosis	Liver Metastases	Liver Metastases + Hepatosplenomegaly	Liver Metastases + Lymphoma	
Abdomino pelvic mass + ovarian Dermoid cysts/ adenexia	-	-	1	-	-	-	-	-	1	-	-	2
	-	-	2.0%	-	-	-	-	-	2.0%	-	-	4.0 %
Ascites/ hepatic lesion	6	1	4	4	2	-	2	-	5	-	-	23
	12.0 %	2.0%	8.0%	8.0 %	4.0%	-	4.0%	-	10.0 %	-	-	48.0 %
Liver Lesions+Ca prostate	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0 %
fatty liver	-	-	-	-	-	1	-	-	-	-	-	1
	-	-	-	-	-	2.0 %	-	-	-	-	-	2.0 %
HCC	-	-	1	-	-	-	-	-	-	-	-	1
	-	-	2.0%	-	-	-	-	-	-	-	-	2.0 %
hepatic lesion + heamoprotenium	-	-	1	-	-	-	-	-	-	-	-	1
	-	-	2.0%	-	-	-	-	-	-	-	-	2.0 %
hepatic lesion + hepatosplenomegaly	-	-	1	-	-	-	-	-	1	1	-	3
	-	-	2.0%	-	-	-	-	-	2.0%	2.0%	-	6.0 %
hepatic lesion + Old TB granuloma	-	-	-	1	-	-	-	-	-	-	-	1
	-	-	-	2.0 %	-	-	-	-	-	-	-	2.0 %
hepatic lesion + sigmoid tumor	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0 %
hepatosplenomegaly + portal hypertension	-	-	-	-	1	-	-	-	-	-	-	1
	-	-	-	-	2.0%	-	-	-	-	-	-	2.0 %
Hydatid liver cyst	1	-	-	-	-	-	-	-	-	-	-	1
	2.0%	-	-	-	-	-	-	-	-	-	-	2.0

												%
liver cyst	1	-	-	-	-	-	1	-	-	-	-	2
	2.0%	-	-	-	-	-	2.0%	-	-	-	-	4.0 %
liver mass	-	-	-	-	-	-	-	-	2	-	-	2
	-	-	-	-	-	-	-	-	4.0%	-	-	4.0 %
liver metastases	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0 %
multiple focal sub-diaphragmatic + sub-capsular lesions multiple mesenteric + para-aortic lymphadenopathies	-	-	-	-	1	-	-	1	-	-	1	3
	-	-	-	-	2.0%	-	-	2.0%	-	-	2.0%	6.0 %
pancreatic tumor +multiple hepatic lesion	2	-	-	-	-	-	-	-	1	-	-	3
	4.0%	-	-	-	-	-	-	-	2.0%	-	-	6.0 %
Right inguinal hernia + liver mass	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0 %
RT renal stone+ hepatic lesion	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0 %
Total	10	1	8	5	4	1	3	1	15	1	1	50
	20.0 %	2.0%	16.0 %	10.0 %	8.0%	2.0 %	6.0%	2.0%	30.0 %	2.0%	2.0%	100. 0%
P-value	≤0.017											

CHAPTER FIVE

Chapter five

Discussion, Conclusion and Recommendation

5-1 Discussion:

Because of the high frequency of diffused or focal liver lesions such as cysts, hemangiomas ,lymphoma ,liver abscess, liver cirrhosis and metastases ;characterization of these lesions is essential. Table (4-1) showed the frequency of the presented cases. Cross tabulation between the CT (diagnosis) and liver texture (homogeneous and heterogeneous) was assessed, the scoring of the liver homogeneity was found to be high,

the study conducted the presence of either focal or diffused liver diseases as presented in table(4-2).Accordingly, the liver lesions were characterized, and the liver CT technique used was suitable for lesion detection and

Characterization, and in order to differentiate lesions ;a triphasic spiral CT technique was applied to image the entire liver in arterial, portal, and equilibrium phases. A contrast material protocol was used to achieve sufficient arterial opacification during the arterial phase, intense parenchyma opacification in the portal phase, and hyperattenuating vascular space in the equilibrium phase.

Table (4-3) showed that the lesion out line and the CT (diagnosis) was found to be significantly correlated at $p \leq 0.000$, that means the shape to be regular or not may indicate the character of the lesion if it is

benign or malignant.

In the hypo attenuating enhancement patterns: the characterization of hypo-attenuating liver lesions is often difficult .Although such lesions may be malignant if found in a patient without a known primary tumor, our study represented 11cases out of 50 as feature of malignancy with metastases and

with /without cirrhosis similar results was found in a study done previously (Jones EC et al, 1992).

The first difference to be noticed between cysts and hypo-attenuating solid lesions is the presence of metastases .All hypo-attenuating- lesions (n = 14/50/22%) with or without liver cirrhosis were found to be cysts or abscess because of their sharper margin and homogeneous hypo-attenuation as presented in table(4-3), liver metastases constituting 11(22.0%) of the cases and also appeared as hypo dense the benign focal lesions ,hepatoma 2(4.0%) and lymphoma 1(2.0%). The diagnoses and changes in the liver feature or lesions attenuation were found to be significantly correlated at $p \leq 0.001$,on the other hand studies had judged that it could not be possible to do a certain diagnosis of benignancy in small lesions and all small hypo-/hypo-(cyst)/hypo- lesions with a standard-of-reference diagnosis represented benign disease.(Maarten et al,1996)

The study reported that liver /spleen size and infection changes (hepatomegaly,splenomegally or hepatosplenomegally)may be associated with hypo intense feature this was presented in table (4-4).

Lesions were grouped in three enhancements patterns, which all demonstrated in the arterial phase, as early enhancement, intermediate enhancement and lesions without enhancement, this was presented in table (4-5).

Tables 4-6and 4- 7 compare the findings in arterial ,venous and delay phase and results showed that 13(26.0%),of the lesions were well enhanced ,19(38%)were intermediately enhanced where 18(36%) reflect no enhancementin the arterial phase. lesions that still enhanced in the delay phase were(9/50/18%)constituting hemangioma8(16%) and liver tumors 1(2%);where in the venous phase the enhanced lesions constituting 30(60%)

and including lesions of liver metastases, hepatoma, hemangioma ,liver tumors with or without hepatic metastases orcirrhosis, while the cyst and abscess score the less values of venous enhancement. These method of evaluationof the liver or hepatic lesions can reflect the feature of the lesions as malignant or benign; this was also been discussed in other similar studies. (Maarten S et al,1996)

We believe that the better results in the current study were achieved because the triphasic spiral CT technique allows optimal use of contrast dynamics due to the speed of data acquisition. Overlapping reconstructions allow centering of the plane of reconstruction with respect to lesions and, thus, leads to a higher percentage of typical appearances. The triphasic liver CT proved to have the ability to facilitate confident characterization of most hepatic lesions, significantly at $p \leq 0.001$ and can give criteria for characterizing lesions adopting to prevent false positive diagnoses as mentioned in the previous studies (Ashida C et al ,1987)

The study represented the interaction between the hepatic lesion and contrast media in the arterial phase and was classified as lesions with no enhancement, lesions with peripheral homogeneous enhancement, peripheral and central enhancement, and lesions with peripheral heterogeneous enhance ,this was noticed in table(4-8).

Characterization of liver and hepatic lesions according to interaction with contrast material was studied in all phase arterial, venous and delay .Liver Cirrhosis affected with tumor showed peripheral heterogeneous enhancement in the arterial phase contrast interaction while hemangioma may appears peripheral homogeneous enhancement 5(10.0%) or peripheral heterogeneous enhancement in 3 (6%) similarly the metastases, while the liver tumors have both features of peripheral and central enhance and

peripheral heterogeneous enhancement. Interaction at venous phase were classified as late ,no enhance or rapid washout. Hepatoma which does not enhanced in arterial phase gives good enhancement as late enhancement at the venous, similar as the hemangiona , while tumors and liver cirrhosis with metastases showed rapid wash out at that phase. This phase can characterize the liver lesions significantly at $p \leq 0.000$.Interaction in delay phase for the malignant hepatic lesions showed no enhancement, liver cirrhosis with tumor constituting 5(10.0%), hepatic tumor with normal liver texture represent 2(4.0%) while cases with hepatic tumor associate liver metastases were 12.0%,however hemangioma were 8(16.0%) and still filled with contrast at that phase. Cysts (simple or hydated) with normal or cirrhotic liver and abscess showed no enhancement at delay phase. These findings were presented in tables((4-8) (4-9),(4-10) .Similarly, studies had mentioned that when lesions demonstrated no enhancement in other phases(hypo-/hypo-/hypo- pattern), lesions was malignant and when an enhancing rim in the arterial phase was observed lesions were malignant. The justification of that appearance in their study and our study as well ,is that the hypervascular rim of hyper-(rim)/ hypo-/hypo- lesions has been well explained and probably represents the well-perfused viable periphery of tumor tissue .(Freeny PCand Marks WM,1986)

These lesions often demonstrated a reversed enhancement pattern in equilibrium phase (a hypoattenuating penipheral rim surrounding a hyper attenuating center) a phenomenon already known as “the washout sign” (Mahfouz AE et al, 1994)

These provide the evidence of our significant results while using triphasic CT in differentiation of lesions.

Table (4-8) represented the interaction of peripheral rim with contrast at the arterial phase .Other studies have observed rim enhancement around abscesses (Brooke JR, 1996), which were present in the current study.

The dual appearance of peripheral interaction in hemangioma gives us clue to have a quit observing appraisal to avoid confusion between the hyper-(rim)/hyper-/hyper- pattern and the peripheral enhancement in hemangiomas. Studies have mentioned that it is essential to differentiate the moderately homogeneous, continuous rim hyper attenuation with parenchyma.

In the hyper attenuating enhancement patterns; recent studies have reported an improvement in lesion detection if arterial phase imaging is performed in addition to portal venous scanning, especially for hyper
vascular lesions. (Murakami T,et al.1995)

Hyper attenuation in the arterial phase showed that if a lesion demonstrates arterial attenuation, either complete or peripheral and extending in a centripetal fashion in subsequent phases, the appearance is pathognic for hemangioma. (Freeny PCand Marks WM,1986)

Therefore our study using triphasic CT give an excellent characteristic of heamangioma. In our study some hemangiomas did not show any enhancement in the arterial phase and only started to enhance in the portal phase, whereas others demonstrated complete enhancement in both the arterial and portal phasesand in the equilibrium phase, comparing with tumors as highly vascular. This phenomenon already described by Freeny and Marks(Freeny PCand Marks WM,1986) who had mentioned that this results due to slow perfusion, concentration of contrast material in the lesion still exceeded the concentration in the vascular system. The combination of all phases allowed us a confident diagnosis of hemangioma making us able

to differentiate hemangiomas from malignant lesions; another study had mentioned the same results and justifications.((Freeny PC and Marks WM,1986)

Metastases were also been evaluated in our study showing results in the above tables (4-8)- (4-9)(4-10), studies had mentioned the metastases from hyper-vascular primary tumors are well depicted on an incremental bolus dynamic scan. (Patten RM, Byun JY and FreenyPC,1993)

Hyper vascular metastases appeared as hyper enhanced lesions and were better delineatedon arterial phase images, while the other metastases were better delineated on portal phase images. In cases of heptomegally without presence of clear hepatic lesions, the changes of texture were also been evaluated in all phases, and it is important to differentiate such a hyper-(wedge)/iso-/iso- pattern, without any sign of focal disease, from areas of contrast enhancement, which may accompany focal liver lesions, probably due to increased arterial supply to the liver region that contains the lesions this also was recommended by other similar studies .(Itai Y, et al .1982)

The goal of imaging in patients with liver lesions is essential in detection and characterization of those lesions. Patients with hepatic malignancy undergo CT examinations to exclude the presence of metastases and to evaluate the extent of local involvement. Diagnostic criteria for benign and malignant focal liver lesions on baseline ultrasound imaging was mentioned previously (Hui-XiongXu, et al 2006).Hemangioma is homogeneous echogenic lesion, echogenic peripheral rim with no or few peripheral or intra lesional flow signals, liver abscess is thick irregular wall, internal anechogenicity or debris, flow signals in the wall liver metastases is heterogeneous echogenic lesion, hypoechoic rim, peripheral or internal arterial flow signals. Liver metastasis is heterogeneous echogenic lesion,

hypoechoic halo, target sign, no or few peripheral flow signals (Hui-XiongXu, et al 2006).

Table (4-11) presented the ultrasound scanning results (liver lesions and associated findings) done for patients before the CT scanning and the data were presented in frequency and percentages. In our cases liver lesions were detected by ultrasonography and were diagnosed according to the above criteria (Hui-XiongXu, et al 2006).

however lesions were not mentioned specifically ;but only it was reported as liver lesions, as well, table(4-12) shows the CT scanning results of liver lesions and associated findings .

Hepatic lesions are difficult to distinguish with imaging criteria alone, however certain focal liver lesions have classic ultrasonic, computed tomographic (CT) characteristics (PremashisKar and Rajat Jain,2011) It is important to emphasize that the primary objective in imaging the liver is to distinguish benign from metastatic and primary malignant lesion1 (PremashisKar and Rajat Jain,2011).Currently, there is no consensus concerning the optimal strategy for imaging the liver for focal liver disease.

Therefore in study, tables (4-12),(4-13) characterized the liver lesion after contrast enhancement according to the shape and enhancement pattern. Our study was interpreted by one radiologist; the enhancement characteristics were assessed by grading the attenuation in comparison to liver parenchyma. Images were reviewed for the presence of focal liver lesions. The appearance of each lesion was described on the basis of the attenuation and the homogeneity of the lesion in comparison to surrounding parenchyma and was expressed as one of the possible states, a) area of water attenuation, homogeneous: hypo dense including (cyst), b) area of soft-tissue

attenuation, often slightly inhomogeneous: hypo dense c)area of hyper attenuation,: hyper dense and d) iso attenuating compared e) moreover, the presence of a continuous, hyper attenuation peripheral rim/hypo attenuating rim, hyper-(rim)/hypo-rim or non enhance were registered.

In our cases multiple of liver lesions were detected as presented in table (4-12) similarly recent studies have reported an improvement in lesion detection when imaging is performed using contrast enhancement patterns especially in the presence of hyper vascular neoplasm, such as hepatocellular Carcinoma (HCC)(Baron RL, et sal 1994), According to the literature and previous experience with dynamic liver CT, many different enhancement patterns were defined (Peterson MS,1992)

Imaging plays an essential role in diagnosis and management of patients with hepatocellular carcinoma. Although ultrasound is currently the main examination imaging tool for HCC (DavarpanahA.H.andWeinreb J.C,2013) ,dynamic cross-sectional CT imaging techniques were also applied for diagnosis and staging of HCC. This is supported by the current technical advances on the CT concerning reduction of radiation exposure, optimization of tissue characterization, development of targeted contrast agents in different enhancement phase. Table (4-15, 4-16) presented the enhancement pattern of the HCC and the liver cirrhoses .A liver mass in a cirrhotic liver should be viewed as an HCC until proven otherwise. The diagnosis of liver masses in a cirrhotic liver includes malignant and benign lesions (Bonaldi VM, 1995). After detecting hepatic mass on ultrasound, the mass was characterized with contrast enhanced multi detector computed tomography .Each modality has its own description of the hepatic lesion and

cirrhosis depending on number of nodules and other factors (Murakami Tm et al,1995)

This current study showed the various characteristics of the liver masses /lesions in cirrhotic and non cirrhotic liver .HCC appears as peripheral enhancement. Cases with cysts appears as non enhanced in 11(22.0%) of the cases as hypo dense non-enhancing focal lesions, similar description was presented in the study done byPremashisKar et al 2011who mentioned that on CT; cysts appear as a well defined intrahepatic lesion having water attenuation (0-15 HU), round or oval in shape with smooth thin walls and homogeneous appearance with no internal structures and no enhancement after contrast administration.

In the current study and regarding the liver abscess; it has been described as peripheral nodular enhancement, rounded hypo dense focal hepatic lesion in 3(6%) of the cases. previous experience has shown that CT is the most accurate method of detection of liver abscess (Rubinson HA, et al 1980) studies showed that the CT diagnosis of liver abscess has limitations. The CT appearance is often nonspecific and non diagnostic. In the series reported, abscesses varied in appearance from smoothly marginated, fluid-filled cavities to poorly defined masses with densities slightly less than surrounding liver. Similar results were reported in the series of RubinsonetaI.(Rubinson et aI1980)in which findings reportedly suggestive of abscess is the demonstration of a hyper dense rim on CT after contrast enhancement this was similar to our study findings. CT diagnostic criterion: is that, not all abscesses exhibit rim enhancement. Callen(Callen PW. 1979) found a definable wall or rim in only **38%** of intra abdominal abscesses. In our study, rim enhancement was seen in 3 cases (6%). The second problem is the non specificity of rim enhancement because both

hyper vascular malignant tumors and hemangiomas may exhibit hyper dense peripheral rims. (Callen PW. 1979) however in the current study Haemangioma were found as peripheral nodular enhancement in 8(16%) of the cases, 6(12%) were oval -shape hypo dense focal hepatic lesion and 2 (4%) were rounded hypo dense focal hepatic lesion after the enhanced CT scan. The usefulness of intravenous contrast media in the detection of liver abscess has been questioned by Rubinson et al. (Rubinson et aI1980) They mentioned that contrast enhancement provided no information that was not already available on unenhanced scans. However our experience differed: in our cases, the abscesses were detected more easily after contrast enhancement the difference in density between the normal and abnormal tissue increased with contrast medium administration. We therefore recommend the routine use of intravenous contrast media during CT evaluation for liver abscess.

Patients with a known or suspect to have hepatic malignancy should undergo abdominal survey examinations to look for liver metastases, lymph node involvement and local involvement.(Chezmar JL et al ,1988)

During our liver evaluation, our study main goal is to determine the presence/absence of hepatic metastases; such examinations were undertaken with a contrast-enhanced CT study since many previous studies have mentioned that CT has high sensibility and specificity for detecting hepatic metastases (Chezmar JL et al ,1988) The study findings shows that most of the liver metastases were demonstrated to have peripheral nodular enhancement which were detected in 16(32%) of the cases .2(4.0%) were hypo dense non-enhancing focal lesions and 14(28.0%) were rounded hypo dense focal hepatic lesion also the involvement of mesenteric and para aortic lymph nodes were detected and described during one CT contrast enhanced

scan, this was presented in tables (4-15,4-16).The current study findings acknowledged the significant relationship between the lesion character and shape and enhancement pattern with the CT diagnosis at $p \leq 0.000$

In the United States, metastatic disease is the most common cause of malignancy in the liver and is more common than primary liver cancer. The colon, stomach, pancreas, and breast are the most common primary sites.(PremashisKar and Rajat Jain,2011) in the current study the colon and pancreas were involved as affected with cancer ,this was diagnosed in both the CT contrast enhanced study and the US examination tables (4-15,4-16,4-17) .The appearance of a new lesion in the liver in a patient with a history of cancer strongly suggests hepatic metastasis. In most series, about one third of patients who die with a malignancy have liver involvement (Schwartz HL,et al ,1999)

Numerous imaging methods are available for detecting hepatic metastatic disease .The usefulness of various imaging modalities can vary significantly across institutions because of local radiological expertise, availability of equipment or personnel, and the wishes and biases of treating physicians and radiologists.(PremashisKar and Rajat Jain,2011)

Ultrasound (US) is the most available technique for liver imaging worldwide, and in many countries is the major modality used to search for liver metastases. In the United States, the relative availability of computed tomography (CT) and limited physician involvement in the performance of US, contribute to a lesser role for US diagnosis. Many patients have liver masses detected by US when suspicion of metastases is not high. In the United States screening for metastases is performed less often with US. Comparative studies demonstrate that US has high specificity but lower sensitivity than other imaging modalities (Mahfouz AE et al ,1996) With

US, metastases can be hypoechoic, hyperechoic, cystic, or diffuse. Metastases frequently displace normal liver vessels.

Radiologist suggested that patients with liver disease at risk for developing hepatocellular carcinoma should undergo periodic liver screening with US, and contrast-enhanced CT which is used for evaluating patients with an abnormal US. This is what was applied in our patients. Studies suggested that when CT is used to characterize a liver lesion detected with US, the CT examination should include arterial phase and portal venous phase imaging as many incidentally discovered liver lesions are hypervascular and therefore may be demonstrated and/or characterized accurately only if arterial phase imaging is included (Van Leeuwen MS, et al ,1996)

When the ultrasound results were correlated with the CT scanning results it showed a significant relationship at $p \leq 0.017$.That means ultrasonography is acknowledged in detection and characterization of liver lesions. Because ultrasonography has excellent spatial and contrast resolution it may therefore provide useful information regarding the liver and liver masses without the use of contrast agents as CT scans. Liver cysts were identified and confidently diagnosed, and a variety of appearances of solid masses suggested a specific diagnosis. Recognition of a hypoechoic halo or rim surrounding an echogenic or isoechoic liver mass, suggested probable malignancy, this was also been mentioned in previous studies (Harvey CJ and Albrecht T.2001) and masses with this morphologic characteristic were provoked confirmatory imaging with computed tomographic (CT) scans ,some showed similar findings and another showed different results as presented in table(4-17) .Multiple hypoechoic masses in the liver most often suggest metastases.(Paulson EK.,2001) this was seen in our results and it was also diagnosed well in the contrast enhanced CT scans.

By comparison, the common appearance of abdomino pelvic mass was diagnosed ultrasonographically with good evaluation of adenexia, it was found as a solid, uniformly echogenic mass, possibly showing increased enhancement deep to the mass, is so well recognized in (1(2%) of the patients with hepatocellular carcinoma (HCC) and 1(2%) of the cases affected with metastases, the identification of such a mass rule out the need for CT imaging where the diagnoses was done regarding to its findings, similar results were reported in previous study. (Bree RL, et al ,1983) However, in patients with HCC ,a variety of metastases from Ca colon, Ca pancreases ,Ca prostate were detected in our cases .Studies have mentioned that there is recognition that lesions with uniformly echogenic mass like may represent malignant liver tumors, (Caturelli E, et al.2001) and confirmation of all such masses using CT scans was done and were significantly correlated with the findings ,our study recommended to use the CT enhancement pattern in the detection and recognition of hepatic masses and lesions. This intense trust on clinical sequence has become part of our practice standard however it highlight the lack of specificity of ultrasonography. With knowledge of the patient's history, different interpretations may result from an identical ultrasonographic appearance. Studies have mentioned that in the cases of a mass like or hepatic lesions, interpretation tends to work relatively well in clinical practice, though it demonstrate the lack of a methodological basis on which the interpretations can be made in the absence of clinical information ,as well the diagnostic criteria of benignancy and malignancy on Ultrasonography showed be considered as homogeneous, hyperechogenicity, hypoechogenicity with hyperechoic rind, posterior enhancement, malignant, hypoechoic halo, target appearance and hypoechoic. HCC varied in characteristics and the

Hemangioma were homogeneous, hyperechogenicity or hypoechoic, with hyperechoic rind or posterior enhancement. Metastasis were hypoechoic ,nonhomogeneous echogenicity or Hypoechoichalo.In many other cases, a mass seen on ultrasonography is referred for contrast-enhanced CT for a confident diagnosis.(Stephanie R,et al ,2007)The assessment of the abdomen is the main role for CT examination, where the major indication is to detect or exclude and characterize focal liver lesions in patients where a primary malignancy is already known in order to search for metastasis and in individuals with a suspected tumor in order to discover the primary site of the malignancy.

Study has some limitations: the small sample size especially for benign lesions. In cases of focal lesion, biopsy was not performed but the diagnosis was based upon the radiologist opinion and the CT/Ultrasound diagnostic criteria. Other potential limitation is that scans were performed on different CT Scanners of different make.

5-2 Conclusion:

The study conclude that:

- Triphasic spiral liver CT enable detection and characterization of a large variety of liver lesions, and multilevel disease.
- Different phase images are helpful in the detection of hyper vascular lesions and are essential for the characterization of a large proportion of lesions.
- Equilibrium phase images aid to demonstrate that characterization of benign focal liver lesions, such as hemangioma and cyst.
- The combination of MDCT and the optimization of contrast-agent administration have significantly improved the quality of multiphase liver imaging with respect to accurate depiction of enhancement as well as through-plane resolution.
- Using thinner slices enable detection of the small lesions. Whereas large tumors reveal typical patterns of morphology, attenuation and enhancement, small lesions still remain challenging even with MDCT, since the specific criteria for confident diagnosis become more ambiguous due to an inherent overlap of CT appearance among lesions.
- US is still limited by its lack of sensitivity in the detection of flow in liver lesions, and the examination procedure is vulnerable by breathing artifacts.
- Finally, Contrast-enhanced CT improves the diagnostic performance in liver lesions compared with baseline Sonography.

5-3 Recommendation

- Triphasic scan must be attended to be faster, more consistent hepatic arterial phase acquisition with a rapid injection of an appropriate volume of IV contrast material to avoid missing of smaller focal lesion.
- The radiologist must carefully assess such imaging features as location, size, and unifocal or multifocal nature of the cyst or cysts as well as evaluate cyst complexity and associated Findings
- It is necessary to integrate imaging with clinical and laboratory findings to allow more definitive diagnosis
- solve and disticunsich between these disease as fast as possible to research to best diagnosis in less time to decrease patient efforts.
- Triphasic MRI for liver should be evaluted wihin triphasic CT liver for more definitive diagnosis.
- However, Our study has some limitations: the small sample size especially for benign lesions.. In cases of focal lesion, biopsy was not performed but the diagnosis was based upon the radiologist opinion and the CT/Ultrasound diagnostic criteria. Other potential limitation is that scans were performed on different CT Scanners of different make. So we recommended to take large samples and also taken biopsy to reach to finial diagnosis.

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APPENDIX

Appendix (A)

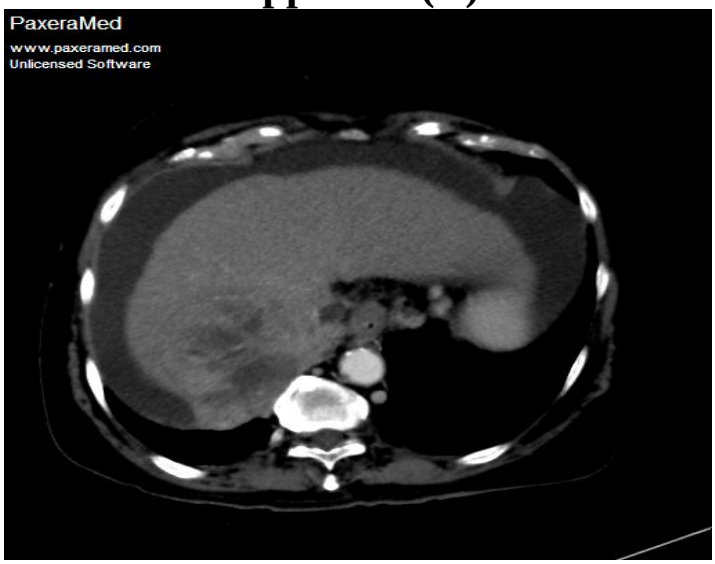
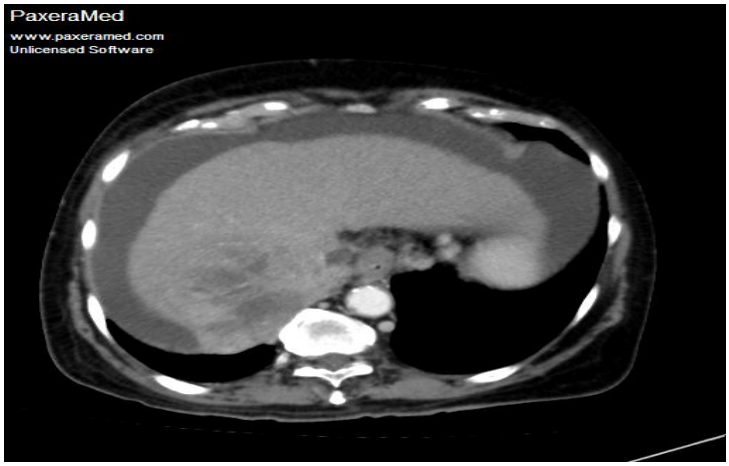
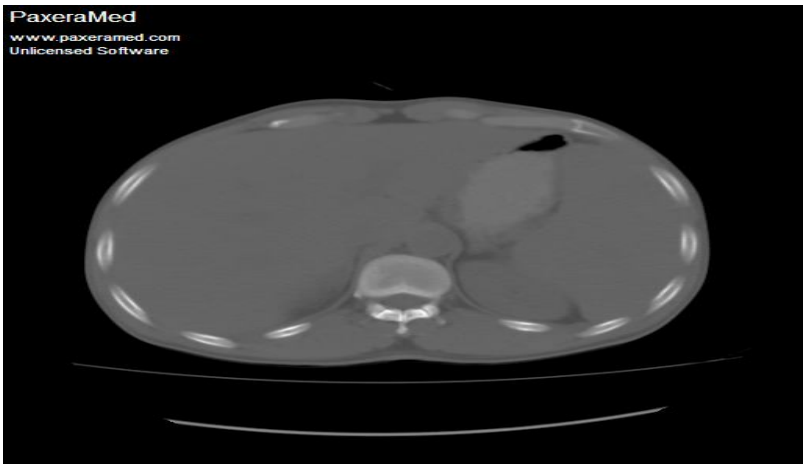


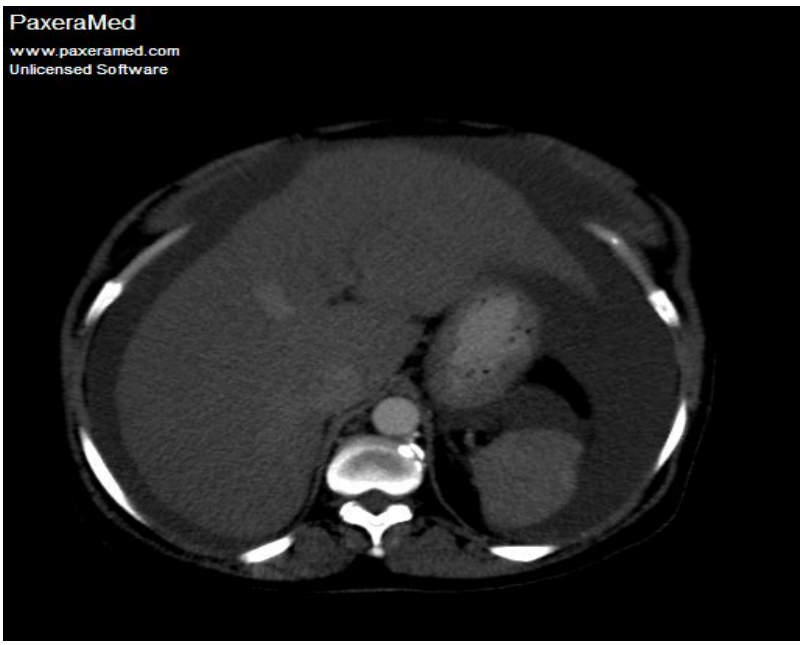
Image (1) :85 yrs Male axial abdominal contrast enhanced CT shown HCC with liver cirrhosis



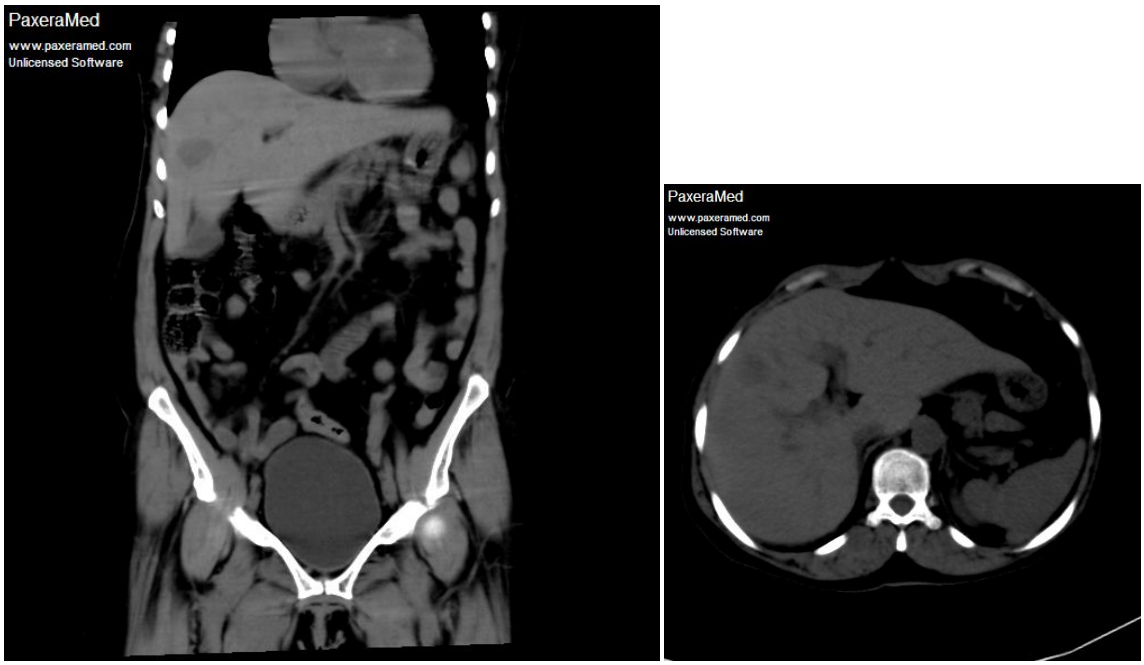
Image(2) : Same pt 85 yrs M axial contrast enhanced CT shown HCC with liver cirrhosis in arterial phase



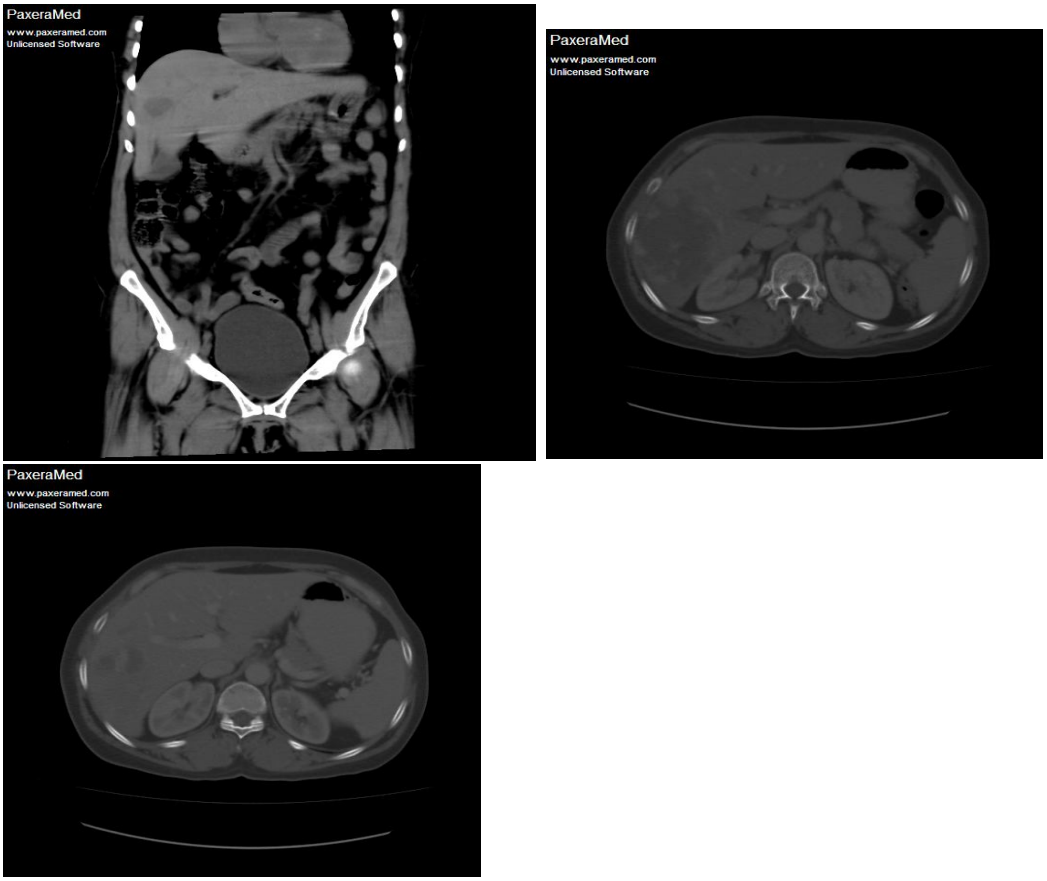
Image(3) :42 yrs Male axial image non enhance CT shown hepatomegaly



Image(4) : 44 yrs F axial image contrast enhanced arterial phase show liver cirrhosis



Image(5): 55 yrs female axial CT show hcc with cirrhotic liver



Image(6): 30 yrs Female hypodense lesion liver mets

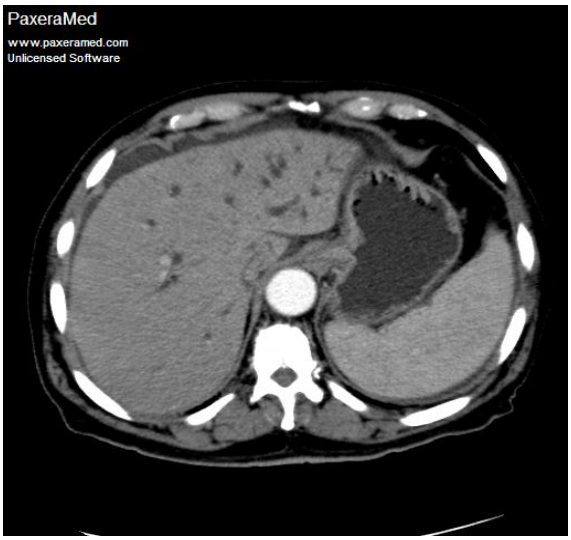
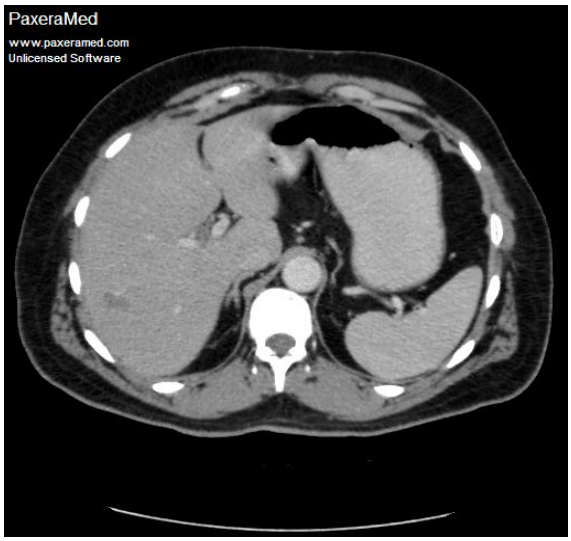


Image (7): 77yrs Male hepatosplenomeglay with biliary dialaittion



Image(8): 37 yrs Male axial CT arterial phase hypodense non enhancement simple cyst

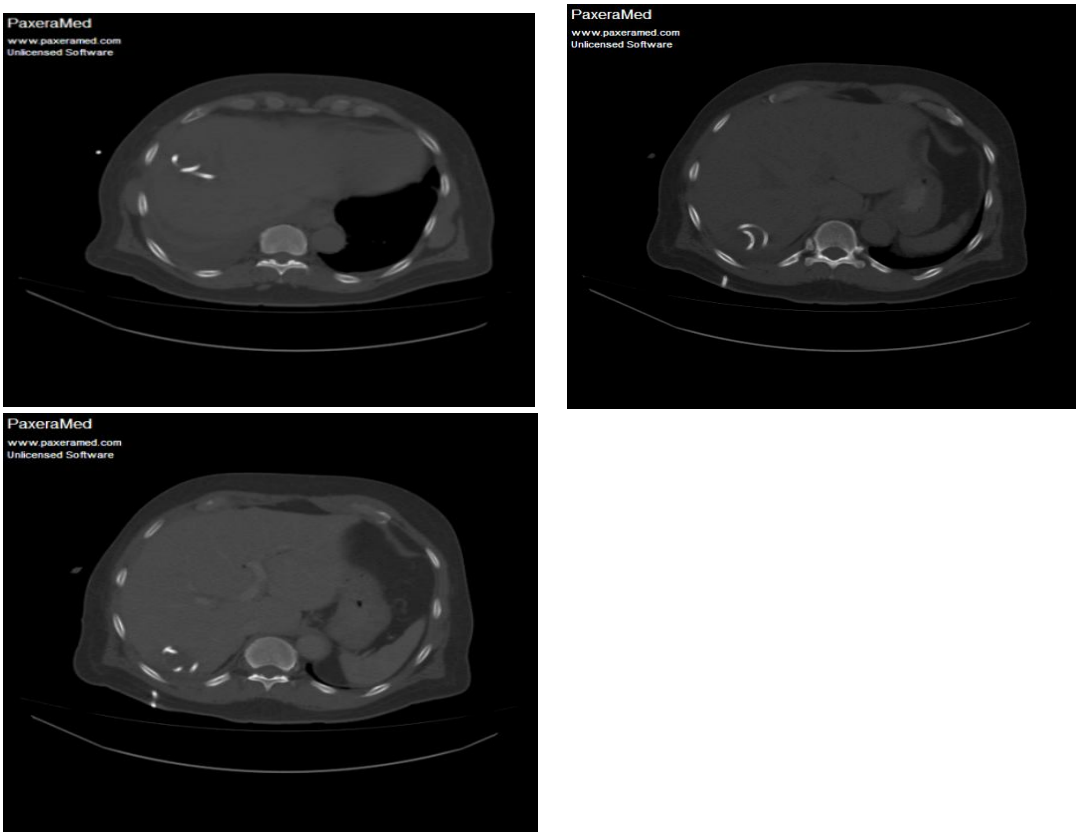


Image (9) :65 yrs Male drained two liver abscess (anterior abcess and posterior one)the last image in arterial phase

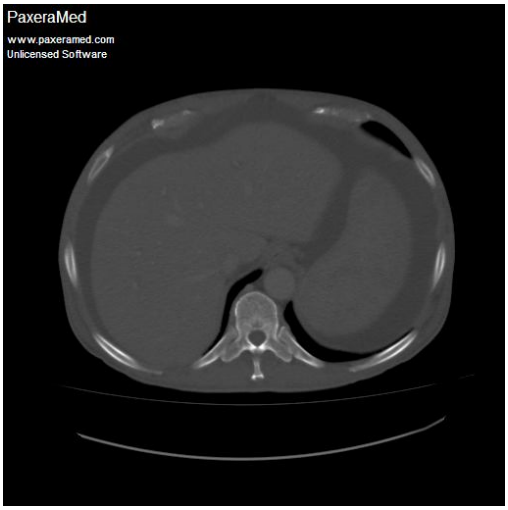


Image (10):63 yrs Male axial CECT venous phase show cirrhotic liver

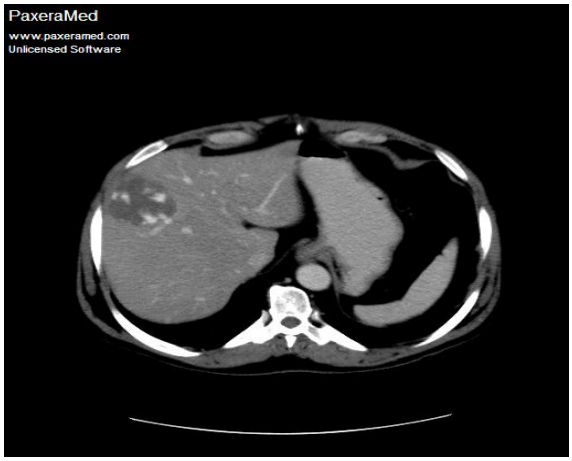


Image (11) : 40 yrs Male axial CT image arterial phase show prephral enhancement of heamangioma

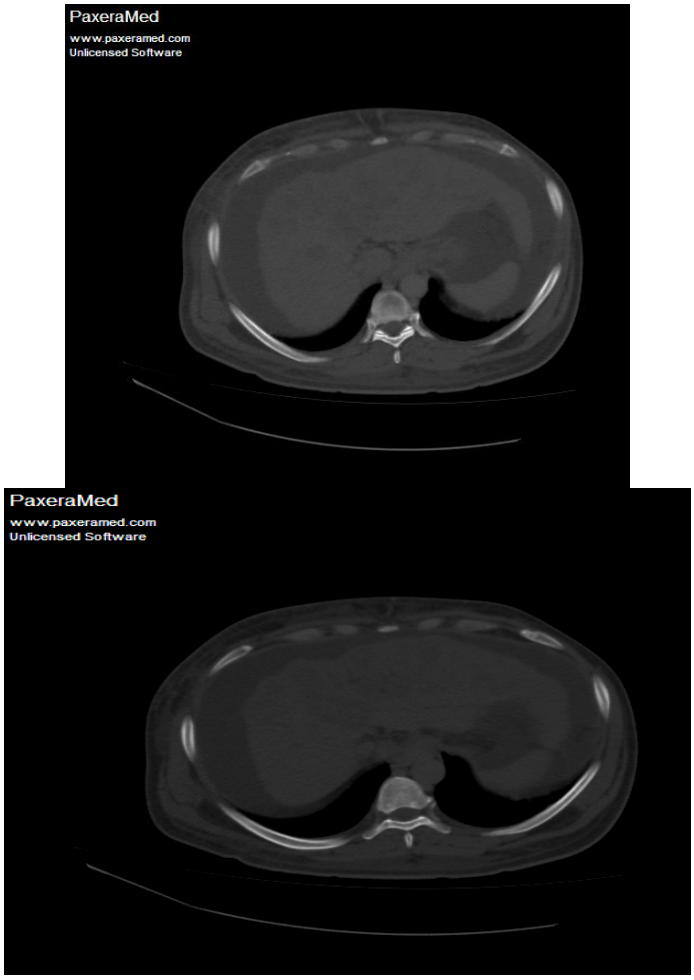
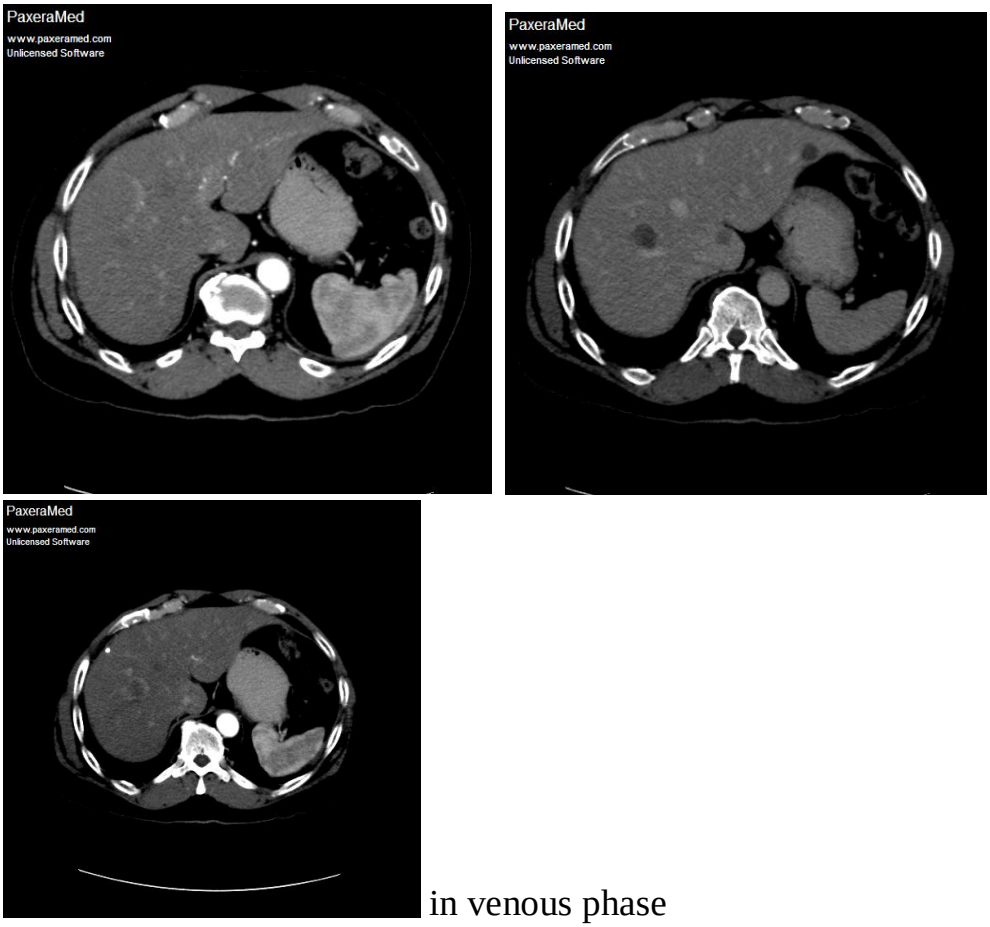


Image (12): 50 yrs Male with asites and HCC with cirrhosis



in venous phase

Image (13) :69 yrs Male a multiple liver mets in arterial phase

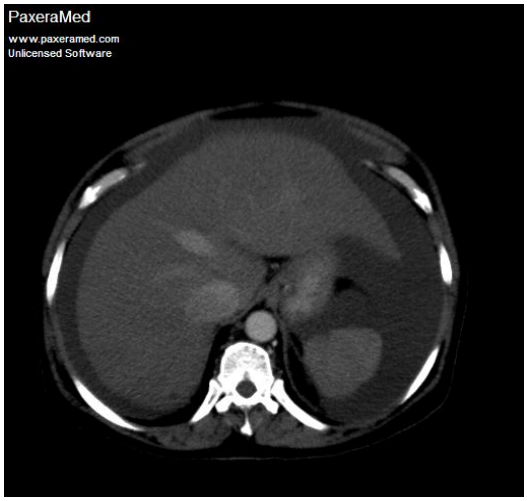


Image (14) : 44 yrs F axial image CT shown massive asities with cirrhotic liver

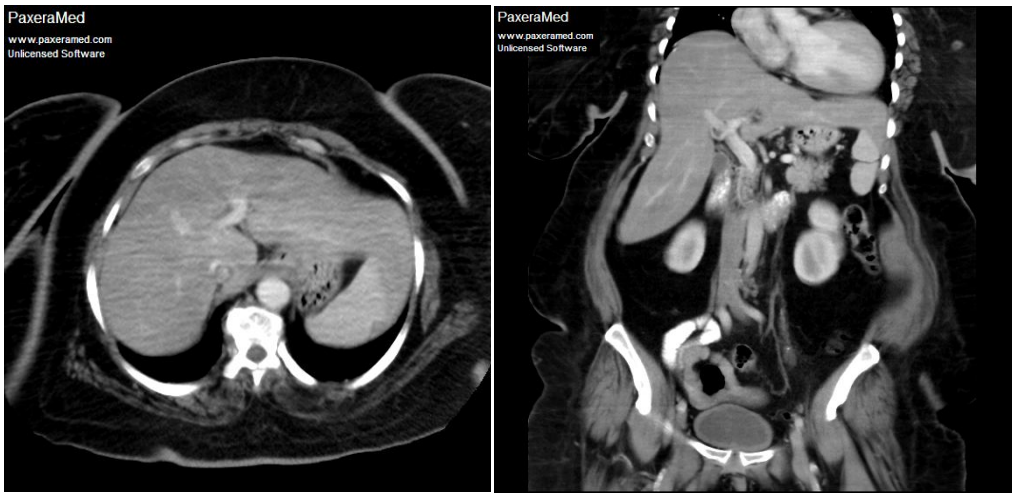


Image (15) :58 Female axial image shown cirrhotic liver and coronal image

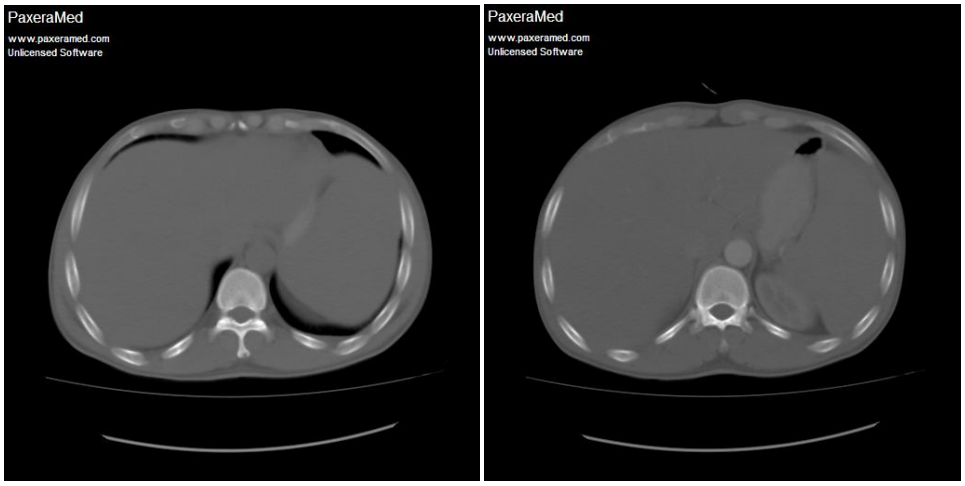


Image (16) :42 yrs Male axial image shown hepatosplenomegaly with hepatitis

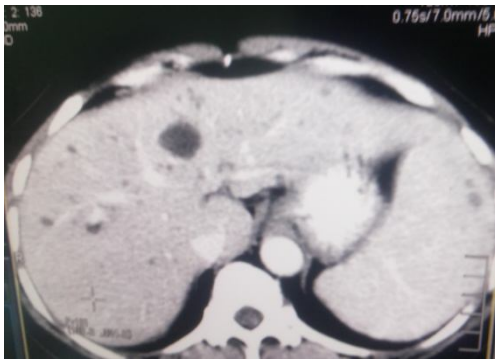


Image (17) :44 yrs Female axial image venous phase show multiple liver mets with hepatosplenomegaly

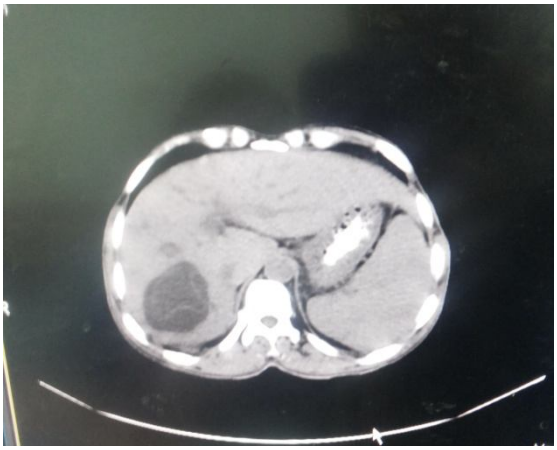


Image (18) : 55 yrs Male axial image CT venous phase show hydatid cyst

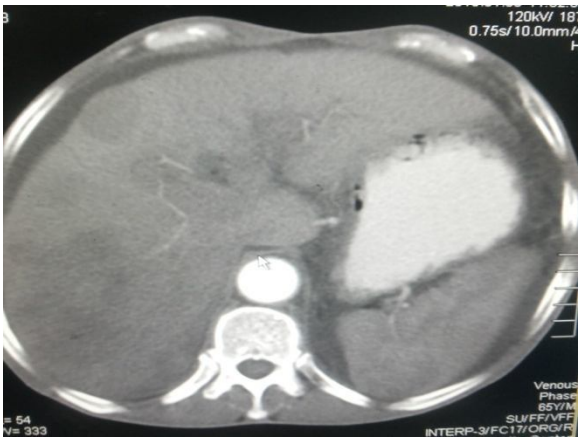


Image (19) :65 yrs Male axial image venous phase show multiple hypodense liver lesion which is liver mets

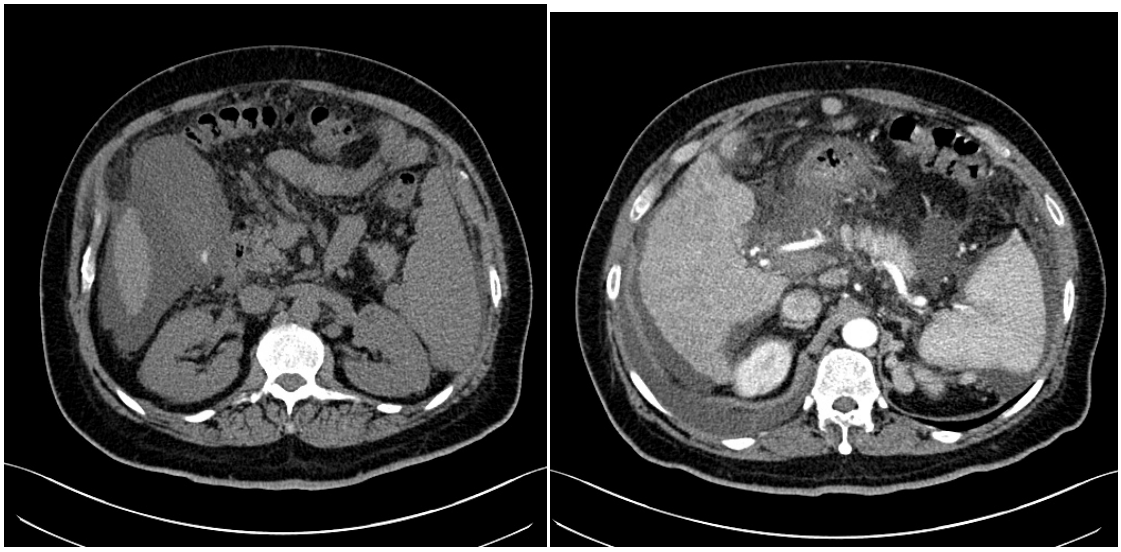


Image (20) : 68 yrs Female axial CT Cirrhotic liver ,the left image same pt in arterial phase

Appendix (B)

Data collection sheet (1)

clinical finding	lab finding	us finding	us features	liver texture	lesion CT No	out line	No of lesion	consitutiation of lesion	site	size (cm)	characterize of lesion	C.M used	enchancemer

Data collection sheet (2)

age	sex	clinical findin	lab finding	us finding	liver texture	lesion CT No	out line	No of lesion	consitutiation of lesion	site	size (CM)	characterize of lesion	C u

enchancement			interacton			CT report (diagnosis)	notice
arterial	venous	delay	arterial	venous	delay		

Hepatic Lesions Enhancement in Multiphasic Contrast-Enhanced Multi Detector Computed Tomography

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Abstract:

PURPOSE: To evaluate whether triphasic spiral CT enables characterization of a wide range of liver lesions.

MATERIALS AND METHODS: 50 patients with suspected liver disease underwent triphasic liver CT. After injection of contrast material, the liver was scanned in arterial, portal and equilibrium phases. Enhancement of each lesion in each phase was evaluated, and the lesions were tabulated according enhancement patterns.

RESULTS: In all patients, liver lesions were detected. The nature of the lesions was characterized in all phases. Enhancement patterns of benign disease, malignant and metastases were also been analyzed..Arterial and venous phase images are helpful in the detection of hyper vascular lesions and are essential for the characterization of a large proportion of lesions. Equilibrium phase images demonstrate benign focal liver lesions, such as hemangioma, cyst, of a hypo-/hypo-(cyst)/hypo- appearance. Hyper-(rim) lesions in patients with a hyper vascular primary tumor or chronic liver disease represented malignant disease. Hypo-/ hypo-/hypo- and hypo-/hypo-/hyper lesions need to be interpreted with caution.

CONCLUSION: Triphasic liver CT enables characterization of a wide range of liver lesions and characterized them significantly at $p \leq 0.000$

Keywords– *Triphasic, Computerized Tomography, Hepatic Lesions*

I. Introduction

Multiphasic contrast-enhanced dynamic CT of the whole liver has played an significant role in the examination for patients with liver disease.[1]

Focal liver lesions can be distinct as any lesion in the liver other than the normal parenchyma with or without causing structural and functional abnormality of hepatobiliary system. Focal liver lesion is more likely to characterize a metastatic deposit than primary malignancy however, hepatocellular carcinoma (HCC) is the most frequent hepatic disorder [2,3] In a patient without known cancer or history of chronic liver disease, these lesions typically can be evaluated with serial follow-up imaging examinations. In patients with cancer, resolving of the cause of such lesions may be essential for defining diagnosis. Small hepatic lesions were believed to be benign with a known underlying malignancy.[4] Most of the hepatic tumors have been reported to be benign in the general population.[5].

Although classic HCCs are commonly hyper vascular and tend to be seen best during the arterial phase of contrast enhancement, some well-differentiated HCCs are relatively hypo vascular and often can be seen only on late phase images [6]

One study reported the value of adding late phase imaging to dual phase helical CT for detection of HCCs [3]. The degree of hepatic parenchyma enhancement depends on a variety of factors which have been well documented and acknowledged in previous studies [7, 8, 9].

It is often difficult to characterize hepatic lesions by imaging. While histopathology is the gold standard, biopsy is always not possible as it is an invasive procedure. Computed tomography (CT) is the imaging modality used to evaluate focal liver lesions, however, the complex blood supply of the liver annoy the application of contrast-enhanced CT protocol for the detection and characterization of focal hepatic lesions.

Characterization of benign focal liver lesions including cysts, haemangiomas is essential. Therefore, the chosen liver CT technique should have a high sensitivity for lesion detection and characterization. To meet these requirements, a triphasic spiral CT technique was developed to image the entire liver in arterial, portal, and equilibrium phases.[10]

In the current study, we evaluated a multiphasic contrast-enhanced spiral computed tomography technique for imaging of the entire liver. Our aim was to evaluate the hepatic enhancement and interaction in patients with liver disease.

II. METHODOLOGY

2.1 PATIENTS AND METHODS

The study was simultaneously conducted in Department of Diagnostic Radiology in CT department in Alfaisal Specialized Hospital, Ibn Alhaitham Diagnostic Centre, Antalya Medical Centre and Royal Care International Hospital. Data was collected from April 2014 to Feb 2015. All the patients of age over 10 years with suspected liver disease were included in the study .By convenient sampling, 50 patients (10-95 years old) were collected randomly from different male and female underwent CT triphaic scan.The data that collected from Alfaisal Specialized Hospital, the CT machine was Toshiba 4 slice (Asteion) using 120 KVP, 200 MAS ,also used triphasic protocol (sure start protocol)manually taken one slice cut above the liver and then begin the scan early arterial phase, venous phase (portovenous phase) and delayed phase with automatic injection flow rate is 4ml/sec,and using 18gague needle for injection .Patient position is supine position feet first. The data that collected from Royal Care International Hospital, the CT machine was Toshiba 64 slice (Aquilion) using 120 KVP, 125 MAS, also used triphasic protocol begin the scan taken early arterial phase, venous phase (portovenous phase) and delayed phase with automatic injection using 70-100 ml omnipaque contrast media with flow rate is 3.5ml/sec. The scan begins immediately after injection and delayed phase are taken after 10 min from injection. Slice

thickness 5mm/slice, patient position is supine position feet first, the oral CM 500ml in 3water bottle each one have 10ml of CM.

The data that collected from Ibn Alhaitham Diagnostic Centre, the CT machine are Toshiba 4 slice (Japan manufactures) using 120 KVP,187 MAS ,also used triphasic protocol begin the scan taken early arterial phase(20sec from injection), venous phase (40 sec) and delayed phase (5-10 min from injection) with automatic injection using 75 ml omnipaque contrast media (40-50 ml for child according to age and weight)for adult with flow rate is 3.5ml/sec.the scan begin immediately after injection and delayed phase are taken after 10 min from injection. Slice thickness 10mm/slice, the oral CM 500ml in 3water bottle each one have 10ml of CM. The first slice are the scout (coronal section) then take plain film without CM then scan triphasic protocol with CM.

Patient position is supine position feet first, from the sternal angle to symphysis pubis. In Antalya medical centre, the CT machine are bride speed 8 slice (American manufactures) using 120 KVP,165 MAS , the scout 120 KVP and 10 MAS also used triphasic protocol begin the scan taken arterial phase ,venous phase and delayed phase (3-6 min from injection) with automatic injection using 75 ml omnipaque contrast media for adult with flow rate is 3.5ml/sec. the scan begin immediately 5 mm /slice thickness then the reconstruction algorithm take 2.5mm.

the first slice are the scout (coronal section)then take plain film without CM then scan triphasic protocol with CM

2.2 STATISTICAL 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.

III. TABLES

Table 1: CT Findings (Diagnosis) In All Of The Examined Cases, Frequency And Percentages

CT (diagnosis)	Frequency	Percentages (%)
Cirrhosis +Liver Metastases	**1**	**2.0**
Calcified Granuloma +Liver Metastases	**1**	**2.0**
Calcified Granuloma+ Liver Abscess	**1**	**2.0**
Cirrhosis	**4**	**8.0**
Cirrhosis + Liver Tumor	**5**	**10.0**
Hemangioma	**8**	**16.0**
Hepatic Tumor	**2**	**4.0**

Hepatic Tumor + Liver Metastases	**1**	**2.0**
Hepatoma	**2**	**4.0**
Hepato-splenomegaly	**4**	**8.0**
Hepato-splenomegaly + Hepatitis	**1**	**2.0**
Hydatic Cyst	**2**	**4.0**
Liver Abscess	**1**	**2.0**
Liver Metastases	**9**	**18.0**
Lymphoma	**1**	**2.0**
Simple Cyst	**6**	**12.0**
Simple Cyst + Cirrhosis	**1**	**2.0**
Total	***50***	***100.0***

Table 2 Cross tabulation between the CT (diagnosis) and liver texture (Homogeneous and Heterogeneous)

		liver texture	Total
		Heterogeneous	**Homogenous**	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	4	0	4
		8.0%	.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	5
		10.0%	.0%	10.0%
	Hemangioma	1	7	8
		2.0%	14.0%	16.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	1	1	2
		2.0%	2.0%	4.0%
	Hepatosplenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%
	Liver Abscess	1	0	1
		2.0%	.0%	2.0%
	Liver Metastases	9	0	9

	18.0%	.0%	18.0%
Lymphoma	0	1	1
	.0%	2.0%	2.0%
Simple Cyst	0	6	6
	.0%	12.0%	12.0%
Simple Cyst + Cirrhosis	1	0	1
	2.0%	.0%	2.0%
Total	27	23	50
	54.0%	46.0%	100.0%
Correlations		***P-value= 0.059***	

Table 3 Cross tabulation between the CT (diagnosis) and lesion out line

		lesion Out Line		**Total**
		Irregular	**Regular**	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Heamangioma	0	8	8
		.0%	16.0%	16.0%
	Calcified Granuloma +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	4	0	4
		8.0%	.0%	8.0%
	Cirrhosis + Hepatic Tumor	5	0	5
		10.0%	.0%	10.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepatosplenomegaly	0	4	4
		.0%	8.0%	8.0%
	Hepatosplenomegaly + Hepatitis	0	1	1
		.0%	2.0%	2.0%
	Hydatic Cyst	0	2	2
		.0%	4.0%	4.0%

Liver Abscess	1	0	1
	2.0%	.0%	2.0%
Liver Metastases	9	0	9
	18.0%	.0%	18.0%
Lymphoma	0	1	1
	.0%	2.0%	2.0%
Simple Cyst	0	6	6
	.0%	12.0%	12.0%
Simple Cyst + Cirrhosis	0	1	1
	.0%	2.0%	2.0%
Total	24	26	50
	48.0%	52.0%	100.0%
Correlations		***P-value= 0.000***	

Table 4 Cross tabulation between the CT (diagnosis) and characterize of lesion (hyper attenuating, hypo attenuating)

		Characterize Of Lesion		**Total**
		Hyper attenuating	**Hypo attenuating**	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	1	3	4
		2.0%	6.0%	8.0%
	Cirrhosis + Liver Tumor	0	5	5
		.0%	10.0%	10.0%
	Hemangioma	0	8	8
		.0%	16.0%	16.0%
	Hepatic Tumor	0	2	2
		.0%	4.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Hepatoma	0	2	2
		.0%	4.0%	4.0%
	Hepato-splenomegaly	0	4	4
		.0%	8.0%	8.0%

Hepato-splenomegaly + Hepatitis	0	1	1
	.0%	2.0%	2.0%
Hydatic Cyst	0	2	2
	.0%	4.0%	4.0%
Liver Abscess	0	1	1
	.0%	2.0%	2.0%
Liver Metastases	0	9	9
	.0%	18.0%	18.0%
Lymphoma	0	1	1
	.0%	2.0%	2.0%
Simple Cyst	0	6	6
	.0%	12.0%	12.0%
Simple Cyst + Cirrhosis	0	1	1
	.0%	2.0%	2.0%
Total	2	48	50
	4.0%	96.0%	100.0%
Correlations		***P=0.001***	

Table 5 Cross tabulation between the CT (diagnosis) and enhancement of the lesion at arterial phase

		Enhancement Arterial Phase			**Total**
		Early Enhance	**Enhance**	**No Enhance**	
CT (diagnosis)	Cirrhosis +Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Cirrhosis	0	0	4	4
		.0%	.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	4	1	0	5
		8.0%	2.0%	.0%	10.0%
	Hemangioma	0	8	0	8
		.0%	16.0%	.0%	16.0%
	Hepatic Tumor	1	1	0	2
		2.0%	2.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%

Hepatoma	0	2	0	2
	.0%	4.0%	.0%	4.0%
Hepato-splenomegaly	0	0	4	4
	.0%	.0%	8.0%	8.0%
Hepato-splenomegaly + Hepatitis	0	0	1	1
	.0%	.0%	2.0%	2.0%
Hydatic Cyst	0	1	1	2
	.0%	2.0%	2.0%	4.0%
Liver Abscess	0	1	0	1
	.0%	2.0%	.0%	2.0%
Liver Metastases	6	3	0	9
	12.0%	6.0%	.0%	18.0%
Lymphoma	0	0	1	1
	.0%	.0%	2.0%	2.0%
Simple Cyst	0	0	6	6
	.0%	.0%	12.0%	12.0%
Simple Cyst + Cirrhosis	0	0	1	1
	.0%	.0%	2.0%	2.0%
Total	13	19	18	50
	26.0%	38.0%	36.0%	100.0%
Correlations		***P-Value= 0.001***		

Table 6 Cross tabulation between the CT (diagnosis) and enhancement of the lesion at Venous Phase

		Enhancement Venous Phase		Total
		Enhance	**No Enhance**	
CT report (diagnosis)	Cirrhosis +Liver Metastases	1	0	1
		2.0%	.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	0	4	4
		.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	5	0	5
		10.0%	.0%	10.0%
	Hemangioma	8	0	8
		16.0%	.0%	16.0%
	Hepatic Tumor	2	0	2
		4.0%	.0%	4.0%
	Hepatic Tumor + Liver Metastases	1	0	1

	2.0%	.0%	2.0%
Hepatoma	2	0	2
	4.0%	.0%	4.0%
Hepato-splenomegaly	0	4	4
	.0%	8.0%	8.0%
Hepato-splenomegaly + Hepatitis	0	1	1
	.0%	2.0%	2.0%
Hydatic Cyst	1	1	2
	2.0%	2.0%	4.0%
Liver Abscess	1	0	1
	2.0%	.0%	2.0%
Liver Metastases	9	0	9
	18.0%	.0%	18.0%
Lymphoma	0	1	1
	.0%	2.0%	2.0%
Simple Cyst	0	6	6
	.0%	12.0%	12.0%
Simple Cyst + Cirrhosis	0	1	1
	.0%	2.0%	2.0%
Total	30	20	50
	60.0%	40.0%	100.0%
Correlations		***P-Value= 0.001***	

Table 7 .Cross tabulation between the CT (diagnosis) and enhancement of the lesion at Delay Phase

		Enhancement At Delay Phase		Total
		Enhance	**No Enhance**	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	1
		.0%	2.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	1
		.0%	2.0%	2.0%
	Cirrhosis	0	4	4
		.0%	8.0%	8.0%
	Cirrhosis + Liver Tumor	1	4	5

	2.0%	8.0%	10.0%
Hemangioma	8	0	8
	16.0%	.0%	16.0%
Hepatic Tumor	0	2	2
	.0%	4.0%	4.0%
Hepatic Tumor + Liver Metastases	0	1	1
	.0%	2.0%	2.0%
Hepatoma	0	2	2
	.0%	4.0%	4.0%
Hepato-splenomegaly	0	4	4
	.0%	8.0%	8.0%
Hepato-splenomegaly + Hepatitis	0	1	1
	.0%	2.0%	2.0%
Hydatic Cyst	0	2	2
	.0%	4.0%	4.0%
Liver Abscess	0	1	1
	.0%	2.0%	2.0%
Liver Metastases	0	9	9
	.0%	18.0%	18.0%
Lymphoma	0	1	1
	.0%	2.0%	2.0%
Simple Cyst	0	6	6
	.0%	12.0%	12.0%
Simple Cyst + Cirrhosis	0	1	1
	.0%	2.0%	2.0%
Total	9	41	50
	18.0%	82.0%	100.0%
Correlations		***P-Value= 0.000***	

Table 8 Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at Arterial Phase

		Interaction At Arterial Phase				Total
		No Enhance	**Peripheral homogeneous Enhance**	**Peripheral And Central Enhance**	**Peripheral Heterogeneous Enhance**	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	0	0	1	1
		.0%	.0%	.0%	2.0%	2.0%
	Calcified Granuloma +Liver Metastases	0	1	0	0	1
		.0%	.0%	.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	0	1

	.0%	2.0%	.0%	.0%	2.0%
Cirrhosis	4	0	0	0	4
	8.0%	.0%	.0%	.0%	8.0%
Cirrhosis + Liver Tumor	0	1	0	4	5
	.0%	2.0%	.0%	8.0%	10.0%
Cyst	1	0	0	0	1
	2.0%	.0%	.0%	.0%	2.0%
Hemangioma	0	5	0	3	8
	.0%	10.0%	.0%	6.0%	16.0%
Hepatic Tumor	0	0	1	1	2
	.0%	.0%	2.0%	2.0%	4.0%
Hepatic Tumor + Liver Metastases	0	1	0	0	1
	.0%	2.0%	.0%	.0%	2.0%
Hepatoma	0	2	0	0	2
	.0%	4.0%	.0%	.0%	4.0%
Hepato-Splenomegaly	4	0	0	0	4
	8.0%	.0%	.0%	.0%	8.0%
Hepato-Splenomegaly + Hepatitis	1	0	0	0	1
	2.0%	.0%	.0%	.0%	2.0%
Hydatic Cyst	1	1	0	0	2
	2.0%	2.0%	.0%	.0%	4.0%
Liver Abscess	0	0	1	0	1
	.0%	.0%	2.0%	.0%	2.0%
Liver Metastases	0	4	0	5	9
	.0%	8.0%	.0%	10.0%	18.0%
Lymphoma	1	0	0	0	1
	2.0%	.0%	.0%	.0%	2.0%
Simple Cyst	5	0	0	0	5
	10.0%	.0%	.0%	.0%	10.0%
Simple Cyst + Cirrhosis	1	0	0	0	1
	2.0%	.0%	.0%	.0%	2.0%
Total	18	16	2	14	50
	36.0%	32.0%	4.0%	28.0%	100.0%

Correlations ***P-Value= 0.000***

Table 9Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at venous Phase

		Interaction At Venous Phase			Total
		Late Enhance	**No Enhance**	**Rapid Washout**	
CT (diagnosis)	Cirrhosis +Liver Metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%
	Calcified Granuloma +Liver metastases	0	1	0	1
		.0%	2.0%	.0%	2.0%
	Calcified Granuloma+ Liver Abscess	0	1	0	1

	.0%	2.0%	.0%	2.0%
Cirrhosis	0	4	0	4
	.0%	8.0%	.0%	8.0%
Cirrhosis + Liver Tumor	0	0	5	5
	.0%	.0%	10.0%	10.0%
Hemangioma	8	0	0	8
	16.0%	.0%	.0%	16.0%
Hepatic Tumor	0	0	2	2
	.0%	.0%	4.0%	4.0%
Hepatic Tumor + Liver Metastases	0	0	1	1
	.0%	.0%	2.0%	2.0%
Hepatoma	2	0	0	2
	4.0%	.0%	.0%	4.0%
Hepato-Splenomegaly	0	4	0	4
	.0%	8.0%	.0%	8.0%
Hepato-Splenomegaly + Hepatitis	0	1	0	1
	.0%	2.0%	.0%	2.0%
Hydatic Cyst	0	2	0	2
	.0%	4.0%	.0%	4.0%
Liver Abscess	0	0	1	1
	.0%	.0%	2.0%	2.0%
Liver Metastases	0	0	9	9
	.0%	.0%	18.0%	18.0%
Lymphoma	0	1	0	1
	.0%	2.0%	.0%	2.0%
Simple Cyst	0	6	0	6
	.0%	12.0%	.0%	12.0%
Simple Cyst + Cirrhosis	0	1	0	1
	.0%	2.0%	.0%	2.0%
Total	10	21	19	50
	20.0%	42.0%	38.0%	100.0%
Correlations		***P-value= 0.000***		

Table 10 Cross tabulation between the CT (diagnosis) and the interaction of the lesion with the contrast material at delay Phase

		Interaction Delay Phase			Total
		Empty	**Filling**	**No Enhance**	
CT report	Cirrhosis +Liver Metastases	1	0	0	1
		2.0%	.0%	.0%	2.0%
	Calcified Granuloma +Liver metastases	0	0	1	1
		.0%	.0%	2.0%	2.0%

Calcified Granuloma+ Liver Abscess	0	0	1	1
	.0%	.0%	2.0%	2.0%
Cirrhosis	0	0	4	4
	.0%	.0%	8.0%	8.0%
Cirrhosis + Liver Tumor	5	0	0	5
	10.0%	.0%	.0%	10.0%
Hemangioma	0	8	0	8
	.0%	16.0%	.0%	16.0%
Hepatic Tumor	2	0	0	2
	4.0%	.0%	.0%	4.0%
Hepatic Tumor + Liver Metastases	1	0	0	1
	2.0%	.0%	.0%	2.0%
Hepatoma	2	0	0	2
	4.0%	.0%	.0%	4.0%
Hepatosplenomegaly	0	0	4	4
	.0%	.0%	8.0%	8.0%
Hepatosplenomegaly + Hepatitis	0	0	1	1
	.0%	.0%	2.0%	2.0%
Hydatic Cyst	1	0	1	2
	2.0%	.0%	2.0%	4.0%
Liver Abscess	1	0	0	1
	2.0%	.0%	.0%	2.0%
Liver Metastases	9	0	0	9
	18.0%	.0%	.0%	18.0%
Lymphoma	0	0	1	1
	.0%	.0%	2.0%	2.0%
Simple Cyst	0	0	6	6
	.0%	.0%	12.0%	12.0%
Simple Cyst + Cirrhosis	0	0	1	1
	.0%	.0%	2.0%	2.0%
Total	22	8	20	50
	44.0%	16.0%	40.0%	100.0%
Correlations		***P-value= 0.000***		

IV. Discussion

Because of the high frequency of diffused or focal liver lesions such as cysts, hemangiomas , Lymphoma ,Liver Abscess, Liver Cirrhosis and metastases ;characterization of these lesions is essential.(Table 1) shows the frequency of the presented cases. Cross tabulation between the CT

(diagnosis) and liver texture (homogeneous and heterogeneous) was assessed , the scoring of the liver homogeneity was found to be high in our cases in the presence of either focal or diffused liver diseases(table2).Accordingly, the liver lesions were characterized, and the liver CT technique used was suitable for lesion detection and characterization, and in order to differentiate lesions a triphasic spiral CT technique was applied to image the entire liver in arterial, portal, and equilibrium phases. A contrast material protocol was used to achieve sufficient arterial opacification during the arterial phase, intense parenchyma opacification in the portal phase, and hyper attenuating vascular space in the equilibrium phase.

Table 3 showed that the lesion out line and the CT (diagnosis) was found to be significantly correlated at $p \leq 0.000$, that means the shape to be regular or not may indicate the character of the lesion if it is benign or malignant.

In the hypo attenuating enhancement patterns: the characterization of hypo-attenuating liver lesions is often difficult .Although such lesions may be malignant if found in a patient without a known primary tumor, our study represented 11cases out of 50 as feature of malignancy with metastases and with /without cirrhosis similar results was found in a study done previously [11].The first difference to be noticed between cysts and hypo-attenuating solid lesions is the presence of metastases .All hypo-attenuating- lesions (n = 14/50/22%) with or without liver cirrhosis were found to be cysts or abscess. Because of their sharper margin and homogeneous hypo-attenuation (table3), liver metastases constituting 11(22.0%) of the cases and also appeared as hypo dense the benign focal lesions. Hepatoma 2(4.0%) lymphoma 1(2.0%). The diagnoses and changes in the liver feature or lesions attenuation were found to be significantly correlated at $p \leq 0.001$,on the other hand studies had judged that it could not be possible to do a certain diagnosis of benignancy in small lesions and all small hypo-/hypo-(cyst)/hypo- lesions with a standard-of-reference diagnosis represented benign disease [12] our study reported that liver /spleen size and infection changes (hepatomegaly,splenomegally or hepatosplenomegally)may be associated with hypo intense feature. This was presented in (table 4).

Lesions were grouped in three enhancements patterns, which all demonstrated in the arterial phase, as early enhancement, intermediate enhancement and lesions without enhancement .this was presented in (table 5). Tables 6and 7 compare the findings in arterial ,venous and delay phase and results showed that 13(26.0%),of the lesions were well enhanced ,19(38%)were intermediately enhanced where 18(36%) reflect no enhancement in the arterial phase. lesions that still enhanced in the delay phase were(9/50/18%)constituting hemangioma 8(16%) and liver tumors 1(2%).where in the venous phase the enhanced lesions constituting 30(60%)and including lesions of liver metastases, hepatoma, hemangioma ,liver tumors with or without hepatic metastases or cirrhosis, while the cyst and abscess score the less values of venous enhancement. These method of evaluation of the liver or hepatic lesions can reflect the feature of the lesions as malignant or benign .this was also been discussed in other similar studies.[12]

We believe that the better results in the current study were achieved because the triphasic spiral CT technique allows optimal use of contrast dynamics due to the speed of data acquisition. Overlapping reconstructions allow centering of the plane of reconstruction with respect to lesions and, thus, leads to a higher percentage of typical appearances. The triphasic liver CT proved to have the ability to facilitate confident characterization of most hepatic lesions, significantly at $p \leq 0.001$ and can give criteria for characterizing lesions adopting to prevent false positive diagnoses as mentioned in the previous studies [13]

The study represented the interaction between the hepatic lesion and contrast media in the arterial phase and was classified as lesions with no enhancement, lesions with peripheral homogeneous enhancement, peripheral and central enhancement, and lesions with peripheral heterogeneous enhance (table 8)

Characterization of liver and hepatic lesions according to interaction with contrast material was studied in all phase arterial, venous and delay .Liver Cirrhosis affected with tumor showed peripheral heterogeneous enhancement in the arterial phase contrast interaction while Hemangioma may appears peripheral homogeneous enhancement 5(10.0%) or peripheral heterogeneous enhancement in 3 (6%) similarly the metastases, while the liver tumors have both features of peripheral and central enhance and peripheral heterogeneous enhancement.Interaction at venous phase were classified as late ,no enhance or rapid washout. Hepatoma which does not enhanced in arterial phase gives good enhancement as late enhancement at the venous, similar as the hemangiona , while tumors and liver cirrhosis with metastases showed rapid wash out at that phase. This phase can characterize the liver lesions significantly at $p \leq 0.000$.Interaction in Delay Phase for the malignant hepatic lesions showed no enhancement ,Liver Cirrhosis with Tumor constituting 5(10.0%) ,Hepatic tumor with normal liver texture represent 2(4.0%) while cases with Hepatic tumor associate liver metastases were 12.0%, however Hemangioma8(16.0%) still filled with contrast at that phase. Cysts (simple or hydated) with normal or Cirrhotic liver and abscess showed no enhancement at delay phase. These findings were presented in tables (8-10)

Similarly, Studies had mentioned that when lesions demonstrated no enhancement in other phases (hypo-/hypo-/hypo- pattern), lesions was malignant and when an enhancing rim in the arterial phase was observed lesions were malignant. The justification of that appearance in their study and our study as well ,is that the hypervascular rim of hyper-(rim)/ hypo-/hypo- lesions has been well explained and probably represents the well-perfused viable periphery of tumor tissue[14,15,16] .These lesions often demonstrated a reversed enhancement pattern in equilibrium phase (a hypoattenuating penipheral rim surrounding a hyper attenuating center) a phenomenon already known as “the washout sign” 17,18] These provide the evidence of our significant results while using triphasic CT in differentiation of lesions.

Table 8 represented the interaction of peripheral rim with contrast at the arterial phase .Other studies have observed rim enhancement around abscesses [19], which were present in the current study.

The dual appearance of peripheral interaction in hemangioma gives us clue to have a quit observing appraisal to avoid confusion between the hyper-(rim)/hyper-/hyper- pattern and the peripheral enhancement in hemangiomas. Studies have mentioned that it is essential to differentiate the moderately homogeneous, continuous rim hyper attenuation with parenchyma.

Hyper attenuating enhancement patterns recent studies have reported an improvement in lesion detection if arterial phase imaging is performed in addition to portal venous scanning, especially for hyper vascular lesions. [20, 21, 22]

Hyper attenuation in the arterial phase showed that if a lesion demonstrates arterial attenuation, either complete or peripheral and extending in a centripetal fashion in subsequent phases, the appearance is pathognomonic for hemangioma[23,] Therefore our study using triphasic CT give an excellent characteristic of heamangioma..In our study some hemangiomas did not show any enhancement in the arterial phase and only started to enhance in the portal phase, whereas others demonstrated complete enhancement in both the arterial and portal phases and in the equilibrium phase, comparing with tumors as highly vascular. This phenomenon already described by Freeny and Marks[23] who had mentioned that this results due to slow perfusion, concentration of contrast material in the lesion still exceeded the concentration in the vascular system. The combination of all phases allowed us a confident diagnosis of hemangioma making us able to differentiate hemangiomas from malignant lesions; another study had mentioned the same results [14]

Metastases were also been evaluated in our study showing results in the above tables (8-10),studies had mentioned the metastases from hyper-vascular primary tumors are well depicted on an incremental bolus dynamic scan .[24-26]

Hyper vascular metastases appeared as hyper enhanced lesions and were better delineated on arterial phase images, while the other metastases were better delineated on portal phase images.

In cases of heptomegally without presence of clear hepatic lesions, the changes of texture were also been evaluated in all phases, and it is important to differentiate such a hyper-(wedge)/iso-/iso-pattern, without any sign of focal disease, from areas of contrast enhancement, which may accompany focal liver lesions, probably due to increased arterial supply to the liver region that contains the lesions this also was recommended by other similar studies [22, 27]

V. Conclusion

Triphasic spiral liver CT is a standardized CT procedure, designed to enable detection and characterization of a large variety of liver lesions, and multilevel disease. The 5-mm portal phase images reconstructed at 2.5mm intervals, acquired at the peak of liver enhancement are the

centerpiece of the protocol and are essential for lesion detection. Different phase images are helpful in the detection of hyper vascular lesions and are essential for the characterization of a large proportion of lesions. Equilibrium phase images aid to demonstrate that characterization of benign focal liver lesions, such as hemangioma, cyst, with a standard character of a hypo-/hypo-(cyst)/hypo- appearance and were considered as benign. Conversely, all hyper-(rim) lesions in patients with a hyper vascular primary

tumor or chronic liver disease represented malignant disease. Hypo-/ hypo-/hypo- and hypo-/hypo-/hyper lesions need to be interpreted with caution.

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Diagnostic Performance of imaging in detection and characterization of liver lesions

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Abstract: *The objective of this study was to evaluate the diagnostic performance of ultrasonography and contrast enhanced computed tomography (CT) in detection and characterization of liver lesions.*

Lesions in 50 patients were examined by sonography and contrast enhanced CT scan. The sonographic images were reviewed by sonologist and the specific diagnoses by CT were recorded. The diagnostic performances including the characterization of each lesion enhancement as peripheral nodular enhancement, non enhance as well as shape including hypo dense non-enhancing focal lesions, as oval - shape hypo dense hepatic lesion, rounded hypo dense focal hepatic lesion were correlated with the final CT and Sonographic diagnosis .

After review of contrast-enhanced CT scan images, the study revealed significant relation between the enhancement, character of the lesions and the sonographic findings with the CT diagnosis at $p < .001$ and $p < .001$ and $p < 0.017$ respectively. Contrast-enhanced CT improves the diagnostic performance in liver lesions compared with baseline sonography.

Keywords : *CT diagnosis, liver lesion, sonography*

VI. Introduction

The diagnostic performance of liver imaging in patients with a history of known or suspected malignancy is essential because the liver is a common site of metastatic spread, and in patients with chronic liver disease who are at risk for developing carcinoma. Since benign liver lesions are common, liver imaging strategies should include liver lesion recognition and classification [1].Several imaging modalities are now available for detection and characterization of liver lesions. These include ultrasonography (US), computed tomography (CT), magnetic resonance imaging (MRI) and nuclear medicine.

It is recognized that the liver has a dual blood supply, the duration of the virtual hepatic arterial phase equals the interval from the beginning of the contrast inflow into the liver from arteries to the beginning of the contrast inflow from the portal vein [2,3,4].Using contrast agents can increase the detection and improve the characterization of focal liver lesions .For optimal lesion detection a good contrast-to noise ratio is essential since detection of these lesions depends mainly on contrast resolution. The contrast depends on the CT attenuation of the focal lesion but also on the liver parenchyma. [5] MDCT CT is the most commonly used imaging modality for both detection and characterization of hepatic metastases [5].

Fatty infiltration of the liver can result in decreased attenuation of the liver and lesion can become imperceptible or even appear hyper attenuating relative to the surrounding parenchyma.

[6,7]. Authors prefer multiple contrast enhanced phases, depending on the indication, including three-phasic protocols evaluation of suspected of HCC [8]. Whether an unenhanced scan is still of value, is under discussion [9, 10]. No or only limited role of unenhanced scan were found for the evaluation of hyper vascular or hypo vascular hepatic metastases [11, 12]. However, Oliver et al. (1998) [13] found that 28% of all hepatic metastases were seen only on the unenhanced scan. At our radiology departments unenhanced scan is performed in baseline studies, because the differentiation between cysts and small hypo vascular metastases and a delineation of calcifications and hemorrhage is improved Although the dynamic CT findings of HCC are well defined, there are few studies to compare imaging findings of HCCs of different etiologies [14,15]

Hemangiomas are often diagnosed by a single dynamic contrast enhanced CT scan. [16] Recent reports have recommended computed tomography (CT) as the primary radiologic method for the detection of suspected hepatic abscess. [17, 18] Despite this recommendation, the CT appearance of hepatic abscess has not been described in detail. In the only reported series with pathologic

documentation, Rubinson et al [18] noted that intrahepatic abscess was often indistinguishable from simple hepatic cyst. However, the frequency of this occurrence was not specified.

Ultrasonography is a relatively inexpensive and noninvasive method of evaluating the upper abdomen. It is especially useful in evaluating for the presence of bile duct obstruction and the presence or absence of gallstones. Ultrasonographyis especially useful in distinguishing between cystic and solid lesions.[19]US is widely available, and many clinicians request US as the initial imaging modality for the assessment of the upper abdomen including the liver to narrow down the differential diagnosis in a relatively quick and cost-effective manner.[20]

In the current study, we evaluated a triphasic spiral CT technique that allowed imaging of the entire liver in arterial, portal and equilibrium phases .The rationale behind the protocol is that the portal phase is the most sensitive phase for lesion detection, whereas the arterial and equilibrium phases can supply additional information on the vascularity of the lesion which may help to identify the nature of lesion.[21-25] The vascular hemodynamic is the key to detect characterization of hyper vascular lesions.

Several studies have been done worldwide on the role of triphasic CT scan in characterizing and differentiating benign and malignant lesions. However, to the best of our knowledge, no data has been published locally, so the purpose of this study was to describe the role of triphasic CT scan in liver lesions and to determine its diagnostic performance in characterization and differentiation liver lesion as it may be difficult to diagnose basing on one imaging study, because of the radiological similarities of lesions. [26] . In recent years many new imaging modalities have been introduced, including ultrasound (US). The question arises which imaging modality performs best in detection and characterization of hepatic lesions and whether we can rely on ultrasound as one of an imaging method for diagnosis liver lesion rather than to obtain CT scanning using radiation exposure. We reviewed the description of the typical features liver lesions on several imaging CT imaging phases and compared the findings with the character of the ultrasound findings .

VII. Materials and Methods

2.1 Patients and Methods

The study was simultaneously conducted in Department of Diagnostic Radiology in CT department in Alfaisal Specialized Hospital, Ibn Alhaitham Diagnostic Centre, Antalya Medical Centre and Royal Care International Hospital. Data were collected from April 2014 to May 2016.

All the patients of age over 10 years with suspected liver disease were included in the study .By convenient sampling, 50 patients were collected from different male and female underwent CT triphaic scan. Distribution of study sample according to participant's age were 25-34 years were 3(6%), 35-44 were 3(6%0) ,45-54 were 9(18.0) 55-64 were 18(36%)65+ were 17(34.0%) with mean age 59.28±12.67, Minimum 27.00years, Maximum 85.00years, 22(44.0%) were males and 28(56.0%) were females

The data that were collected from Alfaisal Specialized Hospital, the CT machine wasToshiba 4 slice (Asteion) using 120 KVP, 200 MAS,also used triphasic protocol (sure start protocol)manually taken one slice cut above the liver and then begin the scan early arterial phase, venous phase (portovenous phase) and delayed phase with automatic injection flow rate is 4ml/sec,and using 18gague needle for injection .Patient position is supine position feet first. The data that collected from Royal Care International Hospital, the CT machine was Toshiba 64 slice (Aquilion) using 120 KVP, 125 MAS, also used triphasic protocol begin the scan taken early arterial phase, venous phase (portovenous phase) and delayed phase with automatic injection using 70-100 ml omnipaque contrast media with flow rate is 3.5ml/sec. The scan begins immediately after injection and delayed phase are taken after 10 min from injection. Slice thickness 5mm/slice, patient position is supine position feet first, the oral CM 500ml in 3water bottle each one have 10ml of CM.

The data that collected from Ibn Alhaitham Diagnostic Centre, the CT machine are Toshiba 4 slice (Japan manufactures) using 120 KVP,187 MAS ,also used triphasic protocol begin the scan taken early arterial phase(20sec from injection), venous phase (40 sec) and delayed phase (5-10 min from injection) with automatic injection using 75 ml omnipaque contrast media (40-50 ml for child according to age and weight)for adult with flow rate is 3.5ml/sec.the scan begin immediately after injection and delayed phase are taken after 10 min from injection. Slice thickness 10mm/slice, the oral CM 500ml in 3water bottle each one have 10ml of CM. The first

slice are the scout (coronal section) then take plain film without CM then scan triphasic protocol with CM.

Patient position is supine position feet first, from the sternal angle to symphysis pubis. In Antalya medical centre, the CT machine are bride speed 8 slice (American manufactures) using 120 KVP, 165 MAS, the scout 120 KVP and 10 MAS also used triphasic protocol begin the scan taken arterial phase, venous phase and delayed phase (3-6 min from injection) with automatic injection using 75 ml omnipaque contrast media for adult with flow rate is 3.5ml/sec. the scan begin immediately 5 mm /slice thickness then the reconstruction algorithm take 2.5mm.

The first slice are the scout (coronal section)then take plain film without CM then scan triphasic protocol with CM .Abdominal ultrasound (US) was performed with phased array transducers operating between 3-5 MHz. Gray scale is an integral part of the examination of the liver, allowing demonstration of hepatic anatomy and pathology as the standard abdominal protocol [19]

2.2 STATISTICAL ANALYSES

All data obtained in the study were documented and analyzed using SPSS program version16. Descriptive statistics, including frequency and percentages, were calculated. ANOVA test was applied to test the significance of differences, *p*-value of less than 0.005 was considered to be statistically significant.

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VIII. Results

Table 1 .Shows The Ultrasound Scanning Results (Liver Lesions And Associated Findings) Done For Patients Before The CT Scanning

Diagnosis	**Frequency**	**Percentages%**
Abdomino Pelvic Mass + Bilateral Ovarian Dermoid Cysts	1	2.0
Ascites + Hepatic Lesion	24	48.0
Hepatic Lesion +Ca Prostate	1	2.0
Fatty Liver	1	2.0
Hepatocelluler carcinoma	1	2.0
Hepatic Lesion + Adnexal Mass	1	2.0
Hepatic Lesion + Heamoprotenium	1	2.0
Hepatic Lesion + Hepatosplenomegaly	3	6.0
Hepatic Lesion + Old TB Granuloma	1	2.0
Hepatic Lesion + Sigmoid Tumor	1	2.0
Hepatosplenomegaly + Portal Hypertension	1	2.0
Hydatid Liver Cyst	1	2.0
Liver Cyst	2	4.0
Liver Mass	2	4.0
Liver Metastases	1	2.0
Multiple Focal Sub-Diaphragmatic + Sub-Capsular Lesions+ Multiple Mesenteric and Para-Aortic Lymphadenopathies	3	6.0
Hepatic Lesion +Pancreatic Tumor	3	6.0
Liver Mass+ Right Inguinal Hernia	1	2.0
Hepatic Lesion+ Right Renal Stone	1	2.0
Total	50	100.0

Table 2. Shows the CT Scanning Results (Liver Lesions and Associated Findings)

	Frequency	Percentages%
Cyst	10	20.0
Cyst + Hepatitis	1	2.0
Haemangioma	7	14.0
Haemangioma + Old Calcified Granuloma	1	2.0
Hepatocelluler carcinoma	5	10.0
Hepatocelluler carcinoma + Liver Cirrhosis	4	8.0
Hepatosplenomegaly	1	2.0
Liver Abscess	3	6.0
Liver Cirrhosis	1	2.0
Liver Metastases	15	30.0
Liver Mets + Hepatosplenomegaly	1	2.0
Liver Metastases + Lymphoma	1	2.0
Total	50	100.0

Table 3 .Characterization of lesion contour by CT Scanning

	Frequency	Percentages%
Hypo dense non-enhancing focal lesions	15	30.0
Oval -shape hypo dense focal hepatic lesion	8	16.0
Rounded hypo dense focal hepatic lesion	27	54.0
Total	50	100.0

Table 4. Characterization of Lesion Enhancement by CT Scanning

	Frequency	Percentages%
Peripheral Nodular Enhancement	36	72.0
Non Enhance	14	28.0
Total	50	100.0

Table 5 .Enhancement patterns of the hepatic lesions cross tabulated with CT scanning diagnosis

CT (diagnosis)	Enhancement pattern		Total
	Non Enhance	Peripheral Nodular Enhancement	
Cyst	10	-	10
	20.0%	-	20.0%
Cyst + Hepatitis	1	-	1
	2.0%	-	2.0%
Haemangioma	-	7	7
	-	14.0%	14.0%
Haemangioma + Old Calcified Granuloma	-	1	1

	-	2.0%	2.0%
Hepatocelluler carcinoma	-	5	5
	-	10.0%	10.0%
Hepatocelluler carcinoma + Liver Cirrhosis	-	4	4
	-	8.0%	8.0%
Hepatosplenomegaly	1	-	1
	2.0%	-	2.0%
Liver Abscess	-	3	3
	-	6.0%	6.0%
Liver Cirrhosis	1	-	1
	2.0%	-	2.0%
Liver Metastases	1	15	15
	2.0%	30.0%	30.0%
Liver Metastases + Hepatosplenomegaly	-	1	1
	-	2.0%	2.0%
Liver Metastases + Lymphoma	-	1	1
	-	2.0%	2.0%
Total	14	36	50
	28.0%	72.0%	100.0%
P-value	0.001		

Table 6 .Characteristic Features of Detected Hepatic Lesions on CT cross tabulated with CT scanning diagnosis

CT Report (Diagnosis)	Lesion Characteristics			Total
	Hypo dense non-enhancing focal lesions	Oval -shape hypo dense focal hepatic lesion	Rounded hypo dense focal hepatic lesion	
Cyst	10	-	-	10
	20.0%	-	-	20.0%
Cyst + Hepatitis	1	-	-	1
	2.0%	-	-	2.0%
Haemangioma	-	6	2	8
	-	12.0%	4.0%	16.0%
Hepatocelluler Carcinoma	-	2	3	5
	-	4.0%	6.0%	10.0%
Hepatocelluler Carcinoma + Liver Cirrhosis	-	-	4	4
	-	-	8.0%	8.0%
Hepatosplenomegaly	1	-	-	1
	2.0%	-	-	2.0%
Liver Abscess	-	-	3	3
	-	-	6.0%	6.0%
Liver Cirrhosis	1	-	-	1
	2.0%	-	-	2.0%

Liver Metastases	2	-	13	15
	4.0%	-	26.0%	30.0%
Liver Metastases + Hepatosplenomegaly	-	-	1	1
	-	-	2.0%	2.0%
Liver Metastases + Lymphoma	-	-	1	1
	-	-	2.0%	2.0%
Total	15	8	27	50
	30.0%	16.0%	54.0%	100.0%
P-value	0.001			

Table 7. Ultrasonographic findings cross tabulated with CT scanning diagnosis

US Report (Diagnosis)			**CT Report (Diagnosis)**									**Total**
	Cyst	**Cyst + Hepatitis**	**Haemangioma + Old Clacified Granuloma**	**HCC**	**HCC+ Liver Cirrhosis**	**Hepatosplenomegaly**	**Liver Abscess**	**Liver Cirrhosis**	**Liver Metastases**	**Liver Metastases + Hepatosplenomegaly**	**Liver Metastases + Lymphoma**	
Abdomino pelvic mass + ovarian Dermoid cysts/ adenexia	-	-	1	-	-	-	-	-	1	-	-	2
	-	-	2.0%	-	-	-	-	-	2.0%	-	-	4.0%
Ascites/ hepatic lesion	6	1	4	4	2	-	2	-	5	-	-	23
	12.0%	2.0%	8.0%	8.0%	4.0%	-	4.0%	-	10.0 %	-	-	48.0%
Liver Lesions+Ca prostate	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
fatty liver	-	-	-	-	-	1	-	-	-	-	-	1
	-	-	-	-	-	2.0%	-	-	-	-	-	2.0%
HCC	-	-	1	-	-	-	-	-	-	-	-	1
	-	-	2.0%	-	-	-	-	-	-	-	-	2.0%
hepatic lesion + heamoprotenium	-	-	1	-	-	-	-	-	-	-	-	1
	-	-	2.0%	-	-	-	-	-	-	-	-	2.0%
hepatic lesion + hepatosplenomegaly	-	-	1	-	-	-	-	-	1	1	-	3
	-	-	2.0%	-	-	-	-	-	2.0%	2.0%	-	6.0%

hepatic lesion + Old TB granuloma	-	-	-	1	-	-	-	-	-	-	-	1
	-	-	-	2.0%	-	-	-	-	-	-	-	2.0%
hepatic lesion + sigmoid tumor	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
hepatosplenomegaly + portal hypertension	-	-	-	-	1	-	-	-	-	-	-	1
	-	-	-	-	2.0%	-	-	-	-	-	-	2.0%
Hydatid liver cyst	1	-	-	-	-	-	-	-	-	-	-	1
	2.0%	-	-	-	-	-	-	-	-	-	-	2.0%
liver cyst	1	-	-	-	-	-	1	-	-	-	-	2
	2.0%	-	-	-	-	-	2.0%	-	-	-	-	4.0%
liver mass	-	-	-	-	-	-	-	-	2	-	-	2
	-	-	-	-	-	-	-	-	4.0%	-	-	4.0%
liver metastases	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
multiple focal sub-diaphragmatic + sub-capsular lesions multiple mesenteric + para-aortic lymphadenopathies	-	-	-	-	1	-	-	1	-	-	1	3
	-	-	-	-	2.0%	-	-	2.0%	-	-	2.0%	6.0%
pancreatic tumor +multiple hepatic lesion	2	-	-	-	-	-	-	-	1	-	-	3
	4.0%	-	-	-	-	-	-	-	2.0%	-	-	6.0%
Right inguinal hernia + liver mass	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
RT renal stone+ hepatic lesion	-	-	-	-	-	-	-	-	1	-	-	1
	-	-	-	-	-	-	-	-	2.0%	-	-	2.0%
Total	10	1	8	5	4	1	3	1	15	1	1	50
	20.0%	2.0%	16.0%	10.0 %	8.0%	2.0%	6.0%	2.0%	30.0 %	2.0%	2.0%	100.0 %
P-value	≤0.017											

IX. Discussion

The goal of imaging in patients with liver lesions is essential in detection and characterization of those lesions. Patients with hepatic malignancy undergo CT examinations to exclude the presence of metastases and to evaluate the extent of local involvement. Diagnostic criteria for benign and malignant focal liver lesions on baseline ultrasound imaging was mentioned previously [27] Hemangioma is homogeneous echogenic lesion, echogenic peripheral rim with no or few peripheral or intralesional flow signals, liver abscess is thick irregular wall, internal anechogenicity or debris, flow signals in the wall liver metastases is heterogeneous echogenic lesion, hypoechoic rim, peripheral or internal arterial flow signals. Liver metastasis is heterogeneous echogenic lesion, hypoechoic halo, target sign, no or few peripheral flow signals[27]

Table (1) presented the ultrasound scanning results (liver lesions and associated findings) done for patients before the CT scanning and the data were presented in frequency and percentages. In our cases liver lesions were detected by ultrasonography and were diagnosed according to the above criteria[27]; however lesions were not mentioned specifically ;but only it was reported as liver lesions, as well, table(2) shows the CT scanning results of liver lesions and associated findings .

Hepatic lesions are difficult to distinguish with imaging criteria alone, however certain focal liver lesions have classic ultrasonic, computed tomographic (CT) characteristics [28] It is important to emphasize that the primary objective in imaging the liver is to distinguish benign from metastatic and primary malignant lesion1 [28].Currently, there is no consensus concerning the optimal strategy for imaging the liver for focal liver disease.

Therefore in our study, tables (2,3) characterized the liver lesion after contrast enhancement according to the shape and enhancement pattern. Our study was interpreted by one radiologist; the enhancement characteristics were assessed by grading the attenuation in comparison to liver parenchyma. Images were reviewed for the presence of focal liver lesions. The appearance of each lesion was described on the basis of the attenuation and the homogeneity of the lesion in comparison to surrounding parenchyma and was expressed as one of the possible states, a) area of water attenuation, homogeneous: hypo dense including (cyst), b) area of soft-tissue attenuation, often slightly inhomogeneous: hypo dense c)area of hyper attenuation,: hyper dense and d) iso attenuating compared e) moreover, the presence of a continuous, hyper attenuation peripheral rim/hypo attenuating rim, hyper-(rim)/hypo-rim or non enhance were registered.

In our study we used the spiral computed tomography (CT) because it has gained approval as the favorite CT technique for routine liver evaluation because it provides image acquisition at peak enhancement of the liver parenchyma [29-32]. 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 multiphasic liver CT. In our cases multiple of liver lesions were detected as presented in table (2) similarly recent studies have reported an improvement in lesion detection when imaging is performed using contrast enhancement patterns especially in the presence of hyper vascular neoplasm, such as hepatocellular Carcinoma (HCC) [33-36].According to the literature and previous experience with dynamic liver CT, many different enhancement patterns were defined [37-39]

Imaging plays an essential role in diagnosis and management of patients with hepatocellular carcinoma. Although ultrasound is currently the main examination imaging tool for HCC [40], dynamic cross-sectional CT imaging techniques were also applied for diagnosis and staging of HCC. This is supported by the current technical advances on the CT concerning reduction of radiation exposure, optimization of tissue characterization, development of targeted contrast agents in different enhancement phase. Table (5, 6) presented the enhancement pattern of the HCC and the liver cirrhoses .A liver mass in a cirrhotic liver should be viewed as an HCC until proven otherwise. The diagnosis of liver masses in a cirrhotic liver includes malignant and benign lesions [34-36] After detecting hepatic mass on ultrasound, the mass was characterized with contrast enhanced multi detector computed tomography .Each modality has its own description of the hepatic lesion and cirrhosis depending on number of nodules and other factors [34]This current study showed the various characteristics of the liver masses /lesions in cirrhotic and non cirrhotic liver .HCC appears as peripheral enhancement. Cases with cysts appears as non enhanced in 11(22.0%) of the cases as hypo dense non-enhancing focal lesions, similar description was presented in the study done by Premashis Kar et al 2011 [28] who mentioned that on CT; cysts appear as a well defined intrahepatic lesion having water attenuation (0-15 HU), round or oval in shape with smooth thin walls and homogeneous appearance with no internal structures and no enhancement after contrast administration.

In the current study and regarding the liver abscess; it has been described as peripheral nodular enhancement, rounded hypo dense focal hepatic lesion in 3(6%) of the cases. previous experience has shown that CT is the most accurate method of detection of liver abscess [18]. studies showed that the CT diagnosis of liver abscess has limitations. The CT appearance is often nonspecific and non diagnostic. In the series reported, abscesses varied in appearance from smoothly marginated, fluid-filled cavities to poorly defined masses with densities slightly less than surrounding liver. Similar results were reported in the series of Rubinson et aI.[41], in which findings reportedly suggestive of abscess is the demonstration of a hyper dense rim on CT after contrast enhancement this was similar to our study findings. CT diagnostic criterion: is that, not all abscesses exhibit rim enhancement. Allen [42] found a definable wall or rim in only **38%** of intraabdominal abscesses. In our study, rim enhancement was seen in 3 cases (6%). The second

problem is the non specificity of rim enhancement because both hyper vascular malignant tumors and hemangiomas may exhibit hyper dense peripheral rims. [42].however in the current study Haemangioma were found as peripheral nodular enhancement in 8(16%) of the cases, 6(12%) were oval -shape hypo dense focal hepatic lesion and 2 (4%) were rounded hypo dense focal hepatic lesion after the enhanced CT scan. The usefulness of intravenous contrast media in the detection of liver abscess has been questioned by Rubinson et al. [18,41]. They mentioned that contrast enhancement provided no information that was not already available on unenhanced scans. However our experience differed: in our cases, the abscesses were detected more easily after contrast enhancement the difference in density between the normal and abnormal tissue increased with contrast medium administration. We therefore recommend the routine use of intravenous contrast media during CT evaluation for liver abscess.

Patients with a known or suspect to have hepatic malignancy should undergo abdominal survey examinations to look for liver metastases, lymph node involvement and local involvement.[43]

During our liver evaluation, our study main goal is to determine the presence/absence of hepatic metastases; such examinations were undertaken with a contrast-enhanced CT study since many previous studies have mentioned that CT has high sensibility and specificity for detecting hepatic metastases [44]. The study findings shows that most of the liver metastases were demonstrated to have peripheral nodular enhancement which were detected in 16(32%) of the cases .2(4.0%) were hypo dense non-enhancing focal lesions and 14(28.0%) were rounded hypo dense focal hepatic lesion also the involvement of mesenteric and para aortic lymph nodes were detected and described during one CT contrast enhanced scan, this was presented in tables (5,6).The current study findings acknowledged the significant relationship between the lesion character and shape and enhancement pattern with the CT diagnosis at $p \leq 0.000$

In the United States, metastatic disease is the most common cause of malignancy in the liver and is more common than primary liver cancer. The colon, stomach, pancreas, and breast are the most common primary sites.[28] in the current study the colon and pancreas were involved as affected with cancer ,this was diagnosed in both the CT contrast enhanced study and the US examination tables (5,6,7) .The appearance of a new lesion in the liver in a patient with a history of cancer strongly suggests hepatic metastasis. In most series, about one third of patients who die with a malignancy have liver involvement.[45,46]

Numerous imaging methods are available for detecting hepatic metastatic disease .The usefulness of various imaging modalities can vary significantly across institutions because of local radiological expertise, availability of equipment or personnel, and the wishes and biases of treating physicians and radiologists.[28]

Ultrasound (US) is the most available technique for liver imaging worldwide, and in many countries is the major modality used to search for liver metastases. In the United States, the relative availability of computed tomography (CT) and limited physician involvement in the performance of US, contribute to a lesser role for US diagnosis. Many patients have liver masses detected by US when suspicion of metastases is not high. In the United States screening for metastases is performed less often with US. Comparative studies demonstrate that US has high specificity but lower sensitivity than other imaging modalities [47, 48, 49] With US, metastases can be hypoechoic, hyperechoic, cystic, or diffuse. Metastases frequently displace normal liver vessels.

Our Radiologist suggested that patients with liver disease at risk for developing hepatocellular carcinoma should undergo periodic liver screening with US, and contrast-enhanced CT which is used for evaluating patients with an abnormal US. This is what was applied in our patients. Studies suggested that when CT is used to characterize a liver lesion detected with US, the CT examination should include arterial phase and portal venous phase imaging as many incidentally discovered liver lesions are hypervascular and therefore may be demonstrated and/or characterized accurately only if arterial phase imaging is included [50,51]

When the ultrasound results were correlated with the CT scanning results it showed a significant relationship at $p \leq 0.017$.That means ultrasonography is acknowledged in detection and

characterization of liver lesions. Because ultrasonography has excellent spatial and contrast resolution it may therefore provide useful information regarding the liver and liver masses without the use of contrast agents as CT scans. Liver cysts were identified and confidently diagnosed, and a variety of appearances of solid masses suggested a specific diagnosis. Recognition of a hypoechoic halo or rim surrounding an echogenic or isoechoic liver mass, suggested probable malignancy, this was also been mentioned in previous studies [52,53] and masses with this morphologic characteristic were provoked confirmatory imaging with computed tomographic (CT) scans ,some showed similar findings and another showed different results as presented in table(7) .Multiple hypoechoic masses in the liver most often suggest metastases.[54]this was seen in our results and it was also diagnosed well in the contrast enhanced CT scans. By comparison, the common appearance of abdomino pelvic mass was diagnosed ultrasonographically with good evaluation of adenexia, it was found as a solid, uniformly echogenic mass, possibly showing increased enhancement deep to the mass, is so well recognized in (1(2%) of the patients with hepatocellular carcinoma (HCC) and 1(2%) of the cases affected with metastases, the identification of such a mass rule out the need for CT imaging where the diagnoses was done regarding to its findings, similar results were reported in previous study. [55] However, in patients with HCC ,a variety of metastases from Ca colon, Ca pancreases ,Ca prostate were detected in our cases .Studies have mentioned that there is recognition that lesions with uniformly echogenic mass like may represent malignant liver tumors, [56] and confirmation of all such masses using CT scans was done and were significantly correlated with the findings ,our study recommended to use the CT enhancement pattern in the detection and recognition of hepatic masses and lesions. This intense trust on clinical sequence has become part of our practice standard however it highlight the lack of specificity of ultrasonography. With knowledge of the patient's history, different interpretations may result from an identical ultrasonographic appearance. Studies have mentioned that in the cases of a mass like or hepatic lesions, interpretation tends to work relatively well in clinical practice, though it demonstrate the lack of a methodological basis on which the interpretations can be made in the absence of clinical information ,as well the diagnostic criteria of benignancy and malignancy on Ultrasonography showed be considered as homogeneous, hyperechogenicity, hypoechogenicity with hyperechoic rind, posterior enhancement, malignant, hypoechoic halo, target appearance and hypoechoic. HCC varied in characteristics and the Hemangioma were homogeneous, hyperechogenicity or hypoechoic, with hyperechoic rind or posterior enhancement. Metastasis were hypoechoic ,nonhomogeneous echogenicity or Hypoechoic halo.In many other cases, a mass seen on ultrasonography is referred for contrast-enhanced CT for a confident diagnosis.[57]The assessment of the abdomen is the main role for CT examination, where the major indication is to detect or exclude and characterize focal liver lesions (1) in patients where a primary malignancy is already known in order to search for metastasis and (2) in individuals with a suspected tumor in order to discover the primary site of the malignancy.

Our study has some limitations: the small sample size especially for benign lesions. Interobserver agreement for interpretation of CT images was not calculated. In cases of focal lesion, biopsy was not performed but the diagnosis was based upon the radiologist opinion and the CT/Ultrasound diagnostic criteria. Other potential limitation is that scans were performed on different CT Scanners of different make.

X. Conclusion

MDCT is a technique with excellent spatial resolution, able to visualize the normal anatomy, as well as any pathologic changes and the relationship to surrounding structures .Additionally, MDCT scanning time has decreased allowing rapid accurate multiphasic imaging with short breath-holding periods. The combination of MDCT and the optimization of contrast-agent administration have significantly improved the quality of multiphasic liver imaging with respect to accurate depiction of enhancement as well as through-plane resolution. Using thinner slices able us to detect the small lesions. Whereas large tumors reveal typical patterns of morphology, attenuation and enhancement, small lesions still remain challenging even with MDCT, since the specific criteria for confident diagnosis become more ambiguous due to an inherent overlap of CT appearance among lesions.Due to the low costs and widespread availability of ultrasound (US) , it always has to be taken into consideration for diagnosing focal liver lesions. However, despite recent improvements in sonographic equipment, US is still limited by its lack of sensitivity in the

detection of flow in liver lesions, and the examination procedure is vulnerable by breathing artifacts. [59]

Finally, Contrast-enhanced CT improves the diagnostic performance in liver lesions compared with baseline sonography .MDCT of the abdomen generates a significant radiation dose to the patient. Thus, the number of necessary scans as well as the application of lower collimation should be strictly checked for each patient with respect to the individual clinical concern and history.

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