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DIAGNOSTIC VALUE OF CT ENHANCEMENT PATTERN OF FOCAL LIVER MASSES.

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Abstract

Objectives: Objectives of the study were to study the Enhancement Pattern of various hepatic masses using Triphasic CT as diagnostic modality, differentiating different hepatic masses and to compare our findings with that reported in literature

Methods:A total of 60 patients were seen in this cross-sectional study done in Department of Radiology,Tikur Anbessa specialized Hospital (TASH) Addis Ababa, Ethiopia from October, 2017 to September, 2018. All patients underwent Triphasic CT examination and diagnosis were made by histopathology/typical imaging findings, follow up, and clinical and lab findings as applicable.

Results: Our study included 60 patients with hepatic focal mass masses; most common neoplasm was metastases (38.3%) followed by hepatocellular carcinoma(HCC)which accounted for 31.6 % and hemangioma which accounted for 15% of cases. Peripheral intrahepatic cholangiocarcinoma accounted for 5 % cases. The enhancement patterns of HCC were as follows: 57.8% demonstrate heterogeneous hypervascularenhancement inthe arterial phase and totally hypovascular in the delayed phase, while 36.8% showed homogeneous hypervascular pattern. Almostall of the HCC (100 %) appeared as totally hypovascularmasses in the delayed phase. In the case of hemangiomas, 73.3 % showsGlobular peripheral enhancement in the arterial phase; in the delayed phase, 60 % showed complete centripetal filling in which is iso vasculartо vessels. In the arterial phase,60.8 % of metastases were hypovascular. In the delayed phase, all (100%) were hypovascular.Metastases were most commonly hypovascular in all phases (60.8%).

Conclusions: Triphasic CT with its high accuracy is helpful in confident diagnosis of a hepatic masses. It has an indispensable role in evaluatingandcharacterizinghepatic masses which helps in guiding appropriate management plan with proper surgical triage.

Keywords
Triphasic MDCT; Focal Liver Masses: Detection and Characterization.

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List of Abbreviations

MDCT…… Multi Detector Computed Tomogram

CT ……. Computed Tomogram

USG……... Ultrasound

HAP……... Hepatic Arterial Phase

PVP…… Portal Venous Phase

DP…….. Delayed Phase

HCC……... Hepatocellular Carcinoma

CA..... Carcinoma

IHBRD.....Intra Hepatic Biliary Radical Dilatation

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: _____

Date: _____

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Chapter 1: Introduction

1.1 BACKGROUND

Liver masses present a relatively common clinical dilemma, particularly with the increasing use of various imaging modalities in the diagnosis of abdominal and other symptoms. The accurate and reliable determination of the nature of the liver mass is critical, not only to reassure individuals with benign masses but also, and perhaps more importantly, to ensure that malignant masses are diagnosed correctly. This avoids the devastating consequences of missed diagnosis and the delayed treatment of malignancy or the unnecessary treatment of benign masses. With appropriate interpretation of the clinical history and physical examination, and the judicious use of laboratory and imaging studies, the majority of liver masses can be characterized noninvasively.

Accurate characterization of liver masses by contrast enhanced Triphasic CT scan imaging is particularly dependent on an understanding of the unique phasic vascular perfusion of the liver and the characteristic behaviors of different masses during multiphasic contrast imaging. When non-invasive characterization is indeterminate, a liver biopsy may be necessary for definitive diagnosis.

1.2 PURPOSES

1. To characterize focal liver masses using contrast enhanced Triphasic liver MDCT by studying the pattern of enhancement of the liver masses in arterial, portal venous and delayed phases.
2. To compare our findings with that reported in literatures.

Chapter 2: Literature Review

Computed Tomography (CT)was invented by Godsfrey Hounsfield and AlanCormack. Obtaining a series of individual scans during suspended respiration performsconventional CT scanning. Between scans, patient is allowed to breathe while the table is moved to the next scanning position. The electrical cabling is incorporated to couple x-ray tube and detector assembly to the reconstruction processor and high voltage power supply. This necessitated oscillatory motion of source-detector assembly within table gantry. Because of repeated stopping, changing direction of motion, and restarting the x-ray tube and detector assembly within the gantry, a delay of 5-10 seconds resultedbetween scans. Slip-ring technology allowed continuous rotation of the x-ray source anddetectors. This not only decreased inters can delays to less than 5 seconds, but has alsomade volume acquisition CT possible. Thus CT has evolved continuously and hasprogressed through several generations of scanner design. The latest stage in thedevelopment of CT has come with introduction of CT scanners where patient translation and data acquisition occur simultaneously through the use of a continuously rotatinggantry and a high heat capacity x-ray tube i.e. helical/spiral CT scanners.

Volume acquisition CT involves continuous patient translation during continuous rotation of the source detector assembly. As a result, a volume data set is obtained within a short period of time, often within a single breath hold of patient. The term helical or spiral CT are derived from the fact that during the scanning process, the x-ray focus follows a helical or spiral path around the patient. After acquisition of the raw projection data set, trans-axial planar images are generated by means of conventional filtered back projection methods after interpolation of projection data between adjacentturns of spiral path. This results in a data volume that may be viewed as conventionaltrans-axial planar images or with multiplanar and three-dimensional methods.The important potential advantages of spiral CT compared with conventional CT are improved lesion detection, lesion densitometry, optimization of enhancement with intravenous contrast material, reduction of total contrast volume and improved multiplanar and three-dimensional reconstructions. The potential for improved lesion detection with spiral CT is mainly due to two main factors: the elimination of respiratory misregistration and the ability to reconstruct overlapping images at arbitrary intervals.

The recent introduction of helical CT scanners with higher heat capacity enables multiple-phase helical examinations of about 20 seconds each with a short time interval. It is widely accepted as the preferred imaging technique for suspected liver tumor and detecting metastases, because of its low cost, high accuracy and ready accessibility. This technology permits examinations of the abdomen in multiple phases with a single monophasic bolus of intravenous contrast material, thus improving lesion detection and characterization of the liver tumors. Helical CT has many advantages over conventional CT for the evaluation of liver tumors. First, the elimination of respiratory misregistration ensures that the entire masses imaged and that the chance of identifying small enhancing masses is maximized. Second, the acquisition of volumetric data during a single breath hold allows a comparison of identical levels on scans obtained before and after administration of contrast material. Third, partial volume averaging is minimized because a section through the center of a lesion is assured with helical CT when overlapping sections are reconstructed. Helical CT has rapidly become the standard in the CT examination of the liver.

Principle of hepatic contrast enhancement:

Primary purpose of contrast injection is to increase the attenuation value difference between normal parenchyma and tumors. When a contrast media is administered intravenously, rapid redistribution takes place from the vascular to the extravascular space, while being continuously excreted by kidney. Thus hepatic parenchymal enhancement is contributed by interstitial contrast material accumulation. Enhancement pattern is best studied in Triphasic CT. There are two phases, arterial (vascular), portal venous phase (redistribution). The vascular phase represents contrast media in vascular compartment, characterized by rapid rise in aortic enhancement. Then hepatic enhancement increases gradually. During redistribution phase, contrast diffuses into extravascular compartment from central blood compartment. Results in rapid decrease in aortic enhancement and concomitant increase in hepatic enhancement indicating that parenchymal enhancement is due to extravascular contrast. Excretion takes place by glomerular filtration.

Intrinsic and extrinsic factors affect hepatic enhancement. Intrinsic factors relate to physiologic and anatomic aspects of the patient and include weight, cardiac function, state of

hydration, renal function, and state of the hepatic vasculature. Extrinsic factors include volume and concentration of the contrast agent, the rate of injection, and technical scan parameters.

Lesion conspicuity will depend on differential enhancement between masses and the adjacent liver parenchyma. Hypervascular metastases may show significant enhancement during the arterial phase. Most liver metastases are hypovascular and are best imaged during the portal venous phase. On arterial phase images of the normal liver, there is little opacification of hepatic veins. The spleen has a characteristics mottled appearance due to the difference in perfusion between the red pulp (vascular lakes) and white pulp (lymphatic follicles). First order branches of proper hepatic artery can be identified on arterial phase.

TECHNICAL FACTORS

With the advent and more common use of helical scanners, the liver can be imaged in less than 20 sec. Helical scanning enables higher injection rates, which shorten the time to peak liver enhancement but have no effect on maximum liver enhancement. Automated bolus detection methods are available that offer precise coordination of the scan initiation with the timing of the contrast bolus. In 1998, Paulson et al, reported that up to 35% of patients in a tertiary care hospital may not achieve a threshold of 50 HU greater than the baseline by 60 sec after injection of contrast material and would require the use of a set time delay. Thus the specific technique used will depend largely on the individual indication for the study.

The detection of hypervascular hepatic masses such as hepatocellular carcinoma, adenoma, focal nodular hyperplasia, and some metastases is improved by obtaining CT images during the arterial phase. The desirable high lesion-to-liver contrast is due to low enhancement of the surrounding hepatic parenchyma during the arterial phase.

Therefore, the optimal arterial phase of the liver should be characterized by a constant arterial supply of contrast material without marked hepatic parenchymal enhancement (<20 HU).

In detecting the majority of metastatic tumors, adequate enhancement of hepatic parenchyma is of the utmost importance. The magnitude of hepatic enhancement is however, determined by a combination of several factors. The most important technique-related factors include the dose (volume and concentration) of intravenous contrast material and the rate of injection of contrast material.

At a given injection rate, the magnitude of peak hepatic contrast enhancement increases linearly with the dose of iodine administered.

As to the minimum volume ofintravenous contrast material required for helical CT of the liver, investigations to date have been somewhat contradictory. Results of the series by Brink et al indicate adequate enhancement with doses of 26-36 g of iodine, whereas Freeny et AL[18]cautioned thatsubstantial reduction of hepatic contrast occurs at doses of 30-32g of iodine (mean bodyweight, 70.2 kg). Similarly, Berl and and Lee et al [13]believe that 45 g of iodine is requiredfor adequate hepatic enhancement.

K Mitsuzaki et al [19]compared two injection protocols and established timing thatwould optimize detection of hepatomas less than 3 cm in diameter. Triple-phase helical CT of the liver was evaluated in 217 patients who had liver cirrhosis and were referred for known or suspected hepatomas. 60% non-ionic contrast material, infused at 2 or 4*ml/sec*, was followed by sequential arterial-phase, portal-venous phase, and equilibrium-phase helical scans of the liver. Aortic and hepatic enhancement curves were constructed by measuring CT attenuation. The CT attenuation values of individual tumor masses were also measured. He compared the degree of enhancement of normal structures and tumors obtained with four scan protocols (injection at 2 ml/sec with a 30-sec scan delay [n = 54],injection at 2 ml/sec with a 35-sec scan delay [n = 47], injection at 4 ml/sec with a 20-sec scan delay [n = 56], and injection at 4*ml/sec* with a 25-sec scan delay [n = 60] and determined the optimal injection protocol and timing for CT acquisition. According to him peak aortic and hepatic enhancement was obtained earlier with the 4-rnl/sec protocol (at 24 sec and 61 sec versus 36 sec and 90 sec for the 2-ml/sec protocol). The peak attenuation value of the aorta was higher with the 4-mil/sec protocol (330 H versus 186 H for the 2-ml/sec protocol). However, peak hepatic attenuation was similar for both protocols (98 H for the 4-ml/sec protocol versus92 H for the 2-ml/sec protocol). Liver-tumor contrast was highest in the arterial phase with both protocols. The next highest contrast was obtained during the equilibrium phase. Liver-tumor contrast in the portal-venous phase was significantly lower than that in the other two phases. Tumor enhancement was significantly higher in scans obtained using the 4- ml/sec protocol with delay time of 25 sec. Thus he concludes that arterial-phase helical CT after 4-ml/sec injection of contrast material significantly improves detection of hepatomas less than 3cm in diameter.

Akihiro Furuta et al [20]evaluated the degree of hepatic enhancement in patients with cirrhosis or chronic hepatitis who underwent multiphasic contrast-enhanced dynamic imaging on MDCT at least twice using standard (300 mg l/ml)and higher (370mg I/ml) iodine concentrations in contrast medium. 20 patients with chronic liver diseases who underwent at least two multiphasic contrast-enhanced dynamic MDCT examinations using 100 ml of standard (300 mg 1/ml = group A) and higher (370mg I/ml= group B) iodine concentrations in contrast medium. Multiphasic scanning obtained 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. His study results were, mean hepatic parenchymal enhancement values in group B was significantly greater than those in group A during the portal phase and the late phase, but the difference on the arteria1 phase images between. The two groups were not significant. The mean aorta-to-liver contrast during the arterial phase in group B was significantly higher than that in group A. Finally he concludes that in patients with chronic liver diseases, a higher iodine concentration (370mg 1/m/) in the contrast medium improves contrast enhancement of liver parenchyma in the portal phase and late phase images and improve diagnostic accuracy for liver diseases on multiphasic contrast-enhanced dynamic MDCT.

Hanninen Enrique et al[21]also evaluated the effect of iodine concentration onthe detection of focal liver masses at biphasic spiral computed tomography. One hundred two patients with neoplastic (n = 85) and non-neoplastic focal masses (n = 17) were prospectively assigned to biphasic injection group A or B and received 180ml of iopramide containing 370 or 300 mg of iodine per milliliter, respectively, during spiral CT. Among patients with hepatocellular carcinoma, mean contrast enhancement in masses in the arterial phase was significantly superior in group A comp ared to group B. The use of a dual-phase CT technique, with imaging during both the arterial and portal venous phases of enhancement, is particularly important for the depiction of hypervascular liver lesion.

NEOPLASMS OF LIVER

Table 1: Classification of Malignant liver tumors

Hepatocellular origin	**Cholangiocellular origin**	**Mesenchymal origin**	**Malignant metastatic masses**
Hepatocellular carcinoma Clear cell carcinoma Giant cell carcinoma Fibro lamellar carcinoma Hepatoblastoma Childhood HC carcinoma Sclerosing hepatic carcinoma	Cholangiocarcinoma Cystadenocarcinoma	Angiosarcoma Epithelioid hemangioendothelioma Leiomyosarcoma Fibrosarcoma Primary lymphoma	

Table 2: Classification of Benign liver tumors

Hepatocellular origin	Cholangiocellular origin	Mesenchymal origin
Hepatocellular adenoma Hepatocellular hyperplasia Focal nodular hyperplasia Nodular regenerative hyperplasia Adenomatous hyperplasia	Hepatic cyst: Simple hepatic cyst Polycystic liver disease Biliary cystadenoma Bile duct adenoma	Mesenchymal hamartoma Hemangioma Infantile hemangioendothelioma Lymphangioma Lipoma Fibroma

Inthe study done on Focal liver masses with the purpose to assess whether Triphasic spiral CT enables characterization of a wide range of focal liver masses. 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 masses were tabulated according to one of 11 enhancement patterns.

In their results, In 94 patients, 375 liver masses were detected. The nature of the lesion was confirmed in 326 masses (87%). Six of 11 enhancement patterns were always due to benign disease and caused by areas with hyper- or hypoperfusion, hemangiomas, cysts, focal nodular hyperplasias, or benign but non-specified masses. 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 elsewhere or with chronic liver disease. The other two patterns were seen in metastases and partly fibrosed hemangiomas.

Finally in their conclusionTriphasic liver CT enables characterization of a wide range of focal liver masses, including the benign liver masses that occur most frequently.

In another study done atDepartment of Radiology, Seoul National University College of Medicine, 28 Yongon-dong, Chongno-gu, Seoul, 110-744, Korea. Address correspondence to J. M. Lee (leejm@radcom.snu.ac.kr).

The purposes of their study were to evaluate the enhancement pattern of HCC smaller than 3 cm in diameter at multiphasic MDCT of a cirrhotic liver according to size and degree of cellular differentiation and to determine the frequency of typical arterial hyper attenuation and early venous washout of HCC depending on tumor size and cellular differentiation.

MATERIALS AND METHODS. In 155 consecutively registered patients (126 men, 29 women; mean age, 58.4 years), 204 pathologically proven HCCs smaller than 3 cm were detected at multiphasic MDCT. Three radiologists in consensus classified the relative attenuation of the tumors compared with the surrounding liver parenchyma as hyper attenuation, iso attenuation, or hypo attenuation on biphasic (n = 86) and Triphasic (n = 69) CT scans.

In their results the prevalent enhancement patterns of HCC differed depending on tumor size. The prevalent pattern of HCC measuring 20–29 mm was arterial hyperattenuation with venous washout (47%, 47/101). The prevalent enhancement patterns of HCC smaller than 10 mm and HCC measuring 10–19 mm were isoattenuation during the arterial and portal venous phases (29%, 6/21) and hyperattenuation and isoattenuation during the arterial and portal venous phases (33%, 27/82).

The typical HCC enhancement pattern (arterial hyperattenuation with venous washout) was identified in 48% (67/141) of the moderately and poorly differentiated HCCs and in 13% (8/63) of well differentiated HCCs.

In their conclusion, the prevalent enhancement patterns of HCC smaller than 3 cm on multiphasic MDCT scans differed depending on tumor size and cellular differentiation. HCCs smaller than 2 cm and well differentiated HCCs frequently had atypical enhancement patterns.

A study conducted in Department of Radiology of Aga Khan University Hospital and Sind Institute of Urology and Transplantation, Karachi from Feb 2006 to Feb 2007 with OBJECTIVE: To assess the diagnostic accuracy of Triphasic spiral CT in differentiating benign from malignant focal tumoral liver masses. By convenient sampling, 45 patients found to have focal tumoral liver masses 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.

In the RESULTS: Among 45 patients, 136 liver masses (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 masses. On later histopathological examination, 35 (77.8%) of the total 45 cases had malignant masses while 10 (22.2%) were diagnosed as benign masses. 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 of 100% and diagnostic accuracy of 95.5% in differentiating benign from malignant liver masses.

In their CONCLUSION, Triphasic CT Scan is a good non-invasive tool in characterizing and differentiating benign from malignant liver masses.

Also in a study conducted with the purpose to describe the appearances of hepatocellular carcinoma including Intralesional contrast washout using a triple-phase liver protocol on an MDCT scanner, Fifty-one patients with newly diagnosed hepatocellular carcinoma underwent standardized triple-phase CT using a multidetector scanner. Pathologic proof was obtained in 35 patients (69%); in 16 patients (31%), hepatocellular carcinoma was diagnosed on clinical and laboratory findings. Two radiologists independently reviewed the CT studies for the appearance and attenuation of the masses. Intralesional washout of contrast material was evaluated subjectively and objectively. Statistical analysis was performed using Fisher's exact test to analyze the relationships between tumor appearance and α-fetoprotein level, tumor grade, and risk factor. Correlation between tumor size and appearance was analyzed using the Student's *t* test and Wilcoxon's rank sum test.

And in their resultsthey show the most common enhancement pattern for hepatocellular carcinoma was hypervascularity on hepatic arterial phase images with a mosaic pattern on both arterial and portal venous images; this finding was seen in 86% and 78% of masses by the two observers, respectively. A hypervascular component was seen in 96% of masses by both observers, and the observers recorded 86% and 63% of masses as showing washout, respectively. Objective washout was present in 76% of masses. Both subjective and objective washout correlated with an elevatedα-feto protein level (p=0.01).

And finally concluded, the appearances of hepatocellular carcinoma on images obtained using MDCT scanners are similar to those described for images obtained using single-detector helical scanners. However, the prevalence of hypervascular hepatocellular carcinoma on MDCT images is higher than previously described on single-detector helical images and most masses showed washout on portal venous MDCT images.

A retrospective study done at Department of Radiology, Yamanashi Hospital, Kofu, Yamanashi, Japan. The study group consisted of 33 patients with cirrhosis (22 men, 11 women; age range, 49–85 years; mean age, 66 years) with 48 HCCs diagnosed histopathologically by biopsy between April 1996 and January 2000. In these patients, positive or suspicious findings for focal liver masses were seen on screening sonography and dynamic CT was performed to confirm the presence of HCCs.

Their objective was to determine the usefulness of delayed phase imaging for detecting small (≤ 2 cm) hepatocellular carcinomas (HCCs) in patients with liver cirrhosis. MATERIALS AND METHODS. Triphasic (arterial, portal venous, and delayed phases) dynamic CT was performed in 33 patients with 48 HCCs proven histopathologically and in 65 control subjects. Arterial, portal venous, and delayed phase images were obtained 30 seconds, 68–70 seconds, and 5 minutes after the start of contrast material injection, respectively. Three blinded observers reviewed the images independently and evaluated tumor attenuation. Diagnostic performance for the combination of phases was assessed using receiver operating characteristic (ROC) curve analysis.

And the RESULTS showed, on arterial phase images, 28 of the 48 HCCs were hyper attenuating, nine were iso attenuating, and 11 were hypo attenuating. On portal venous phase images, three tumors were hyper attenuating, 17 were iso attenuating, and 28 were hypo attenuating. On delayed phase images, five tumors were iso attenuating, and 43 were hypo attenuating. The mean sensitivity for the combination of arterial and portal venous phase imaging was 86.8%, that for the combination of arterial and delayed phase imaging was 90.3%, and that for the combination of all three phase imaging was 93.8%. The area underneath composite ROC curve (A*z*) for the combination of all three phase imaging (Az= 0.940) was significantly higher than that for the combination of arterial and portal venous phase imaging (Az= 0.917) and for the combination of arterial and delayed phase imaging (Az= 0.922).

In their CONCLUSION, Delayed phase imaging is useful for detecting small HCCs and should be included in dynamic CT examinations of patients with liver cirrhosis.

2.1 ANATOMY

EMBRYOLOGY

By the beginning of the fourth week of embryonic development, the liver primordium first appears as a thickening of the endodermal cells on the ventral surface of the most caudal part of the foregut, where foregut becomes continuous with the stalk of the yolk sac. As these cells

proliferate they form a hepatic diverticulum or liver bud, which extends into the septum transversum as strands of rapidly proliferating cells. As the hepatic diverticulum enlarges, it divides into a cranial portion, which becomes the liver primordium proper and a caudal portion, which becomes the gallbladder and extrahepatic bile ducts.

Larger cranial liver primordium gives rise to the interlacing cords of hepatic cells and the intrahepatic portion of biliary apparatus. Hepatic cell cords invade first the vitelline and then the umbilical venous plexus within the septum transversum. These venous channels eventually become the hepatic sinusoids. Mesoderm of the septum transversum gives rise to the connective tissue stroma of the liver, the kupffer cells and the hematopoietic cells of the embryonic liver and the hepatocytes are formed from the hepatic buds.

MORPHOLOGICAL ANATOMY

Liver is the largest organ in the abdomen occupying most of the right upper quadrant. It is bordered superolaterally by the surface of the diaphragm and medially by the stomach, duodenum and transverse colon. Inferiorly it is related to the hepatic flexure of colon, kidney and adrenal glands. Liver is attached to the diaphragm by falciform ligament. Superolaterally and inferolaterally coronary ligament comes together to form the right and left triangular ligament. Most surfaces of the liver are covered by peritoneal reflections with exceptions of, fossa for IVC, the fossa for the gallbladder and the barearea of the liver, posteriorly where the liver comes in direct contact with the diaphragm.

LOBAR ANATOMY

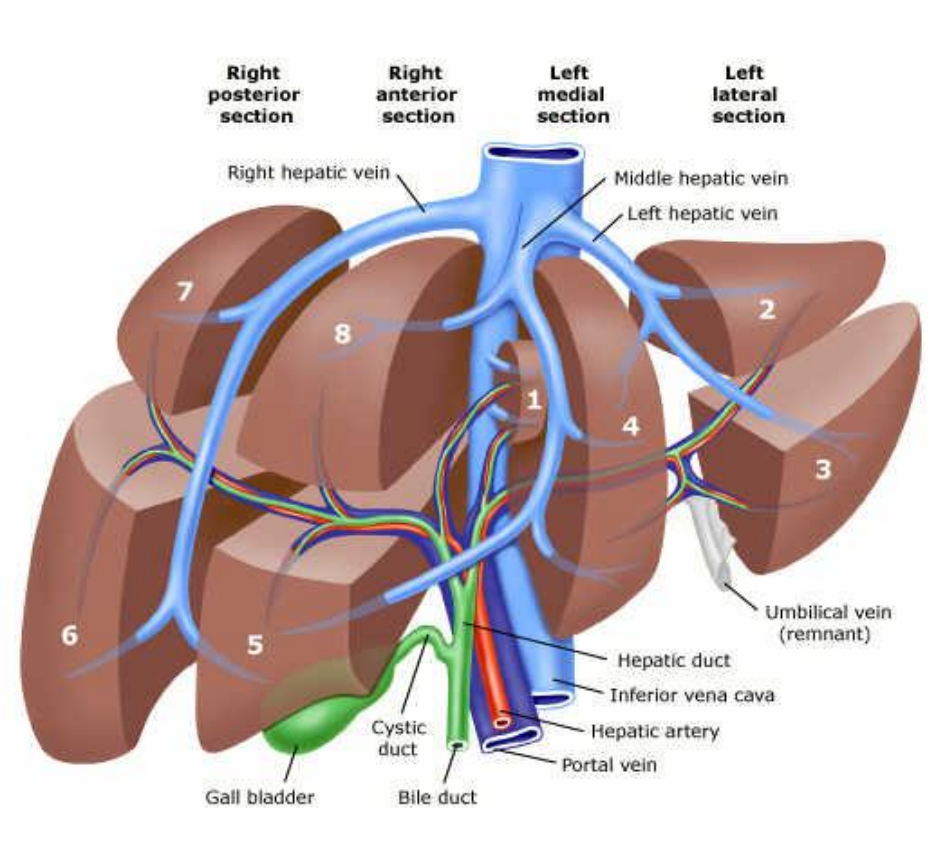
Liver structure is based on the lobar anatomy of a large right and smaller left lobe as well as an anatomically distinct caudate lobe. Caudate lobe abuts the inferior aspect of the right lobe and is separated from the left lobe by the fissure of ligamentum venosum.

Three hepatic fissures help in defining the margins of the hepatic lobes and major hepatic segments. The interlobar fissure is an incomplete structure oriented along the line passing through the gall bladder inferiorly and the middle hepatic vein superiorly. Informs the inferior margin of the border between the right and left lobes. Left intersegmental fissure (fissure for ligamantum teres) is oriented in a sagittal plane and divides the left lobe in to medial and lateral segments. Another fissure, the fissure for ligamentum venosum is oriented in coronal or oblique

plane between the left lateral segment and the anterior aspect of the caudate lobe. This fissure contains a portion of gastrohepatic ligament.

Caudate lobe is a pedunculated portion of the right lobe, which lies between theIVC and right branch of portal vein. It is an autonomous part of liver from a functional point of view because it has separate blood supply, bile drainage and venous drainage. More medial extension of caudate lobe is called the papillary process.

Figure 1: **Segmental anatomy of liver**



SEGMENTAL ANATOMY

Couinaud and Bismuth proposed segmental anatomy of liver for surgical planning of sub segmental hepatic resection. Hepatic anatomic nomenclature is based on the distribution of blood

vessels and bile ducts within the liver. As the branches of portal vein, hepatic artery and bile ducts course together as a portal triad, they serve specific lobes and segments. Similarly hepatic veins drain in an organized fashion from specific segments and lobes to the inferior vena cava. Portal triad course within the segments of the liver, while the venous drainage course between the segments and lobes forming the marginal anatomy of the liver segments, along with other fissures and ligaments. Middle hepatic vein delineates the separation between the right and left lobes. The right lobe is comprised of an anterior and posterior segment and the right hepatic vein superiorly depict the boundary between these two segments. Similarly left hepatic vein depicts the boundary between medial and lateral segments of the left lobe. Inferiorly, the landmarks for the liver segments are also well defined. The left intersegmental fissure contains fat, the ligamentum teres and part of left portal vein. It extends sagitally through the left lobe of the liver along its mid and inferior portion. This divides the medial and lateral segments of the left lobe. The interlobar fissure is depicted as a plane extending from the recess of the gallbladder fossa through the IVC. There is no well-defined fissure between anterior and posterior segments of the right lobe. This border is approximated by a plane bisecting the liver parenchyma between the anterior and posterior branches of the right portal vein, continuing superiorly to the right hepatic vein.

Because of new surgical techniques allowing for subsegmentectomy, Goldsmith and Woodburne proposed segmental anatomy, but detail was inadequate for surgical resection, so Bismuth et al proposed a more detailed classification of liver segmental anatomy.

This classification uses the planes of right and left portal branches, the so-called transverse incisura, to divide each segment into superior and inferior sub segments.

Figure 2: CT segmental Imaging Anatomy of Liver

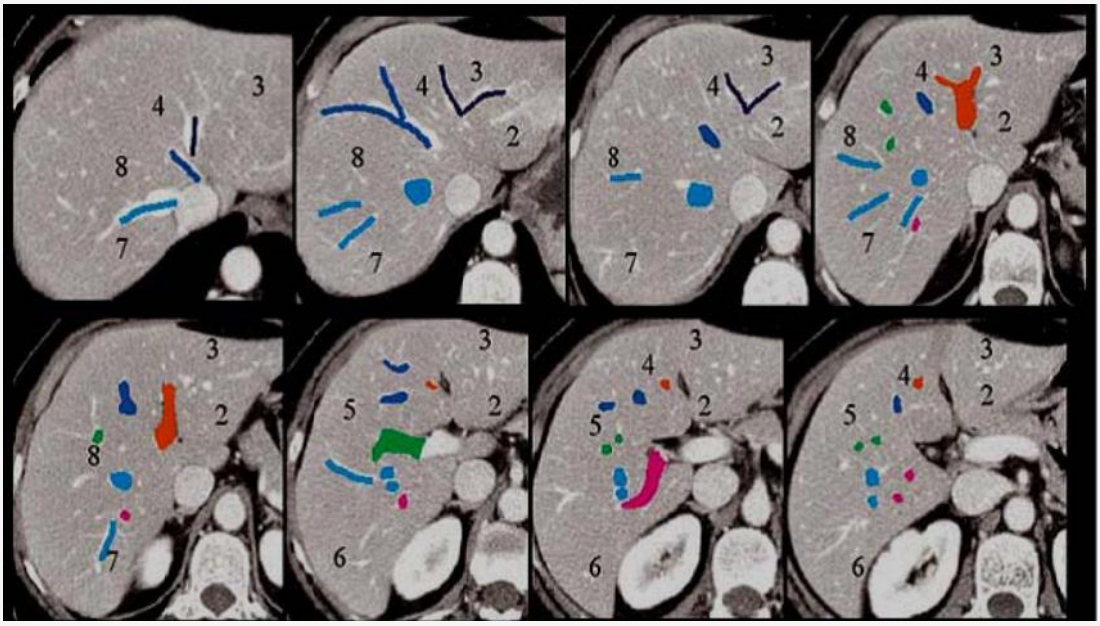


Table 3:Totally 8 segments are numbered in a clockwise manner

Caudate lobe Segment 1	Segment 1
Left lateral segment Superior	Segment 2
Left lateral segmentinferior	Segment 3
Left medial segmentSuperior	Segment 4a
Left medial segment Inferior	Segment 4b
Right anterior segment superior	Segment 5
Right anterior segment Inferior	Segment 8
Right posterior segment Superior	Segment 6
Right posterior segment Inferior	Segment 7

VASCULAR ANATOMY

Afferent blood supply to the liver is through the hepatic artery and the portal vein which along with bile ducts forms the portal triad. Hepatic veins are efferent vessels, which drain in to the inferior vena cava. Portal vein runs posterior to common bile duct and hepatic artery. Hepatic artery supplies 25 -30% of blood flow whereas portal vein supplies 75% of blood supply. Hepatic artery is a branch of coeliac axis and runs in the hepatoduodenal ligament. At porta hepatis, hepatic artery and bile ducts arc anterior to the portal vein, artery occupying more medial position. Within the porta, hepatic artery divides in to right and left hepatic branches. Within the liver they divide in a same fashion as portal vein and supply corresponding segments. Variations in hepatic artery include the left hepatic artery originating from the left gastric artery and right hepatic artery originating from the superior mesenteric artery.

Hepatic veins are three in number, the right, middle and left hepatic veins which drain in to IVC. Right hepatic vein drains the segment V, VI and VII. Left hepatic vein drains segment II and III. Middle hepatic vein drains segment IV, V and VIII. In 90% of cases middle hepatic vein and left hepatic veins join and form a common trunk and then drain in to IVC.

Portal vein originates posterior to the neck of the pancreas at the confluence of superior mesenteric and splenic vein. Then it runs in the free margin of lesser omentum (hepatoduodenal ligament). At porta, portal vein divides in to right and left branches. Within the liver right portal vein divides in to anterior and posterior branches, each of these again divides in to superior and inferior subdivisions. Left portal vein traverse horizontally, giving off branches that supply the lateral segments. Later Left branch of portal vein runs cranially and terminates in to ascending and descending branches.

Normal hepatic parenchyma is homogenous in appearance. Attenuation value of liver parenchyma on unenhanced scans range from 40-70 HU. Normally attenuation value of liver is 8-10 HU more than spleen, this is due to high glycogen content of the liver

On post contrast attenuation value of liver parenchyma depends on the timing of scan.

Chapter 3: Research Design

This is a prospective study conducted in the department of the radiology at Tikur anbessa hospital. The study was conducted from January 1, 2018 to September 2018. A total of 60 patients were selected for the study in which diagnosis was correlated by any of the following criteria.

1. US guided /CT guided FNAC wherever available
2. By typical imaging findings
3. Clinical and lab findings

Cases with focal liver masses were included and cases with only simple cysts, oncologic patients with known metastasis or cases in which final diagnosis not made on the basis of imaging/histopathology or clinical details were excluded from the study.

The study protocol includes a proforma for each patient which include name, age, sex hospital no. a history of the patient regarding the nature of the clinical presentation, routine clinical and biochemical investigation were revised from each patients charts.

Imaging technique

All CT examinations were performed in helical CT scanner (general electric bright speed helical scanner). In acquisition of all images, parameters used were a tube voltage of 120 kvp, a tube current of between 200-300mA and a pitch of 1:1. Images were obtained after injecting 100ml of iopramide 300mg through iv cannula in calibrated power injection at a rate of 3-3.5ml/sec. In children dose of contrast media was calculated according to the body weight. Dual phase scanning was started with 18-20 sec delay for arterial phase, 60 sec delay for portal venous phase, Slice thicknesses were reduced 1mmwith retro reconstruction.

CT Analysis

CT examinations were interpreted by the radiologists specialized in GI Imaging. The contour and size of the liver was studied. In patients with more than one lesion, the largest lesion was chosen as representative of all masses if the masses

have same CT characteristics.The tumors were evaluated for the number of masses, the location of the lesion, size of the lesion which included its maximum diameter, its margins whether well-defined or ill-defined. The presence of calcification and vascular affection particularly in the form of portal vein involvement, hepatic vein and inferior vena canal involvement was studied. Miscellaneous findings like presence of ascites, presence of enlarged lymph nodes, pleural effusion and metastases to other organs like lung, adrenal and bone were evaluated. Enhancement pattern of the tumors in the arterial, portal venous and delayed phases were noted. Enhancement of the masses was tabulated as the attenuation of tumor with respect to the hepatic parenchyma. i.e. iso vascular, hypervascularor hypovascular. The enhancement was further studied with regard to following features- homogenous-heterogeneous, peripheral ring type, globular enhancement pattern and centripetal filling pattern (in delayed images).

Pattern of enhancement were grouped in categories and criteria's used for eachcategory were:

The "Homogeneous pattern was defined as

- Diffuse uniform enhancement with no more than 10% central low attenuation
- With any evident vessels having normal contour and branching.

The "abnormal internal vessels or variegated" pattern was defined as either visible internal vessels that were irregular in contour and branched in a distorted fashion unlike normal progressive anatomic arborization or randomly distributed hyper attenuating and hypo attenuating regions.

The "Attenuation" of the tumor was defined relative to the liver parenchyma during same phase of imaging that is either arterial or portal venous phase.

The "peripheral globular" pattern was defined as

discrete well defined peripheral enhancing globules less than 1cm with attenuation equal to that of enhancing arterial structures.

The “complete ring” pattern was defined as

> circumferential ring enhancement surrounding a predominant central region with low attenuation.

The “Capsule” was considered to be present

> when a thin curvilinear border surround the tumor and distinctly differed in attenuation from the adjacent liver parenchyma.

“Lymphadenopathy” was considered when the size was more than 1 cm in short axis.

3.1 ETHICS AND LIMITATIONS

Ethical clearance was obtained from the ethical review committee of the CHS of Addis Ababa University and was submitted to Tikur Anbessa specialized hospital radiology department administrators. Accordingly, permission letter was secured from head in chief of radiology department. In addition all of the study participants was informed about the purpose of the study and oral/verbal consent was obtained.

Chapter 4: Results

In our study, studied patients comprises of cases with age ranging from 21 year to 78 years with the maximum number of cases in the age group of 51 to 65 years (45%). 60% of cases were males and 40 % were females.

Table 4: Age distribution of patients studied

AGE	Frequency	Percent
20-30	4	6.7
31-40	12	20.0
41-50	15	25.0
51-65	27	45.0
66+	2	3.3
Total	60	100.0

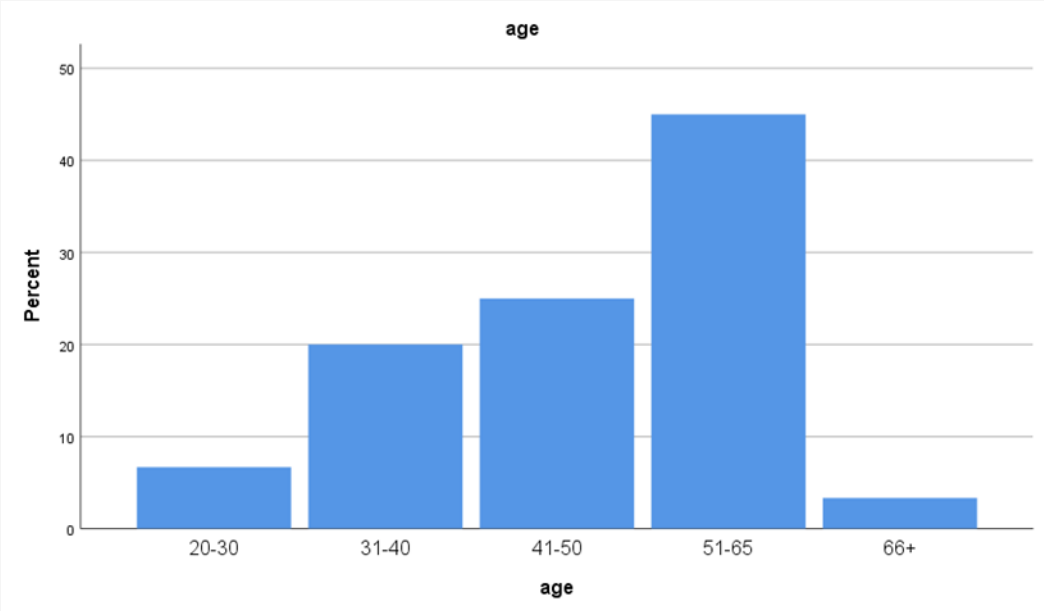


Table 5: Sex distribution of patients studied

Gender	Number	Percent
Female	24	40
Male	36	60
Total	60	100.0

In our study, there was a male preponderance (60%) when compared to females who accounted for (40%) of cases.

Table 6: Distribution of focal liver masses according to age in years

		AGES				
		20-30	31-40	41-50	51-65	66+
CASES	Cholangiocarcinoma	1	0	2	0	0
	HCC	2	4	6	6	1
	Hemangioma	0	4	4	6	1
	metastasis	1	4	3	15	0
Total		4	12	15	27	2

Regarding age distribution of individual focal liver masses in our study:

Out of 60 patients studied,

- 45 patients were diagnosed to have malignant (75%) focal liver masses and 15 patients had benign (25%) focal liver masses.
- Overall most common malignant focal lesion was metastases accounting for 38.3% of the cases; however most common primary malignant lesion was HCC accounting for 31.7% of cases. 65.2% of the total metastases were seen in age range of 51-65 years.63.1% cases of HCC were seen in age range of 41-65 years.
- The youngest patient with HCC was between 22 yearsold malepatient and the oldest patient withHCC was78 years old male patient. The mean age was 50 years. 2 patients with intrahepatic CCA were seen in age range of 41-50 years.

- Of the patients with benign masses, hemangiomas were the most common masses seen in 15 patients accounting for 25% of the cases.

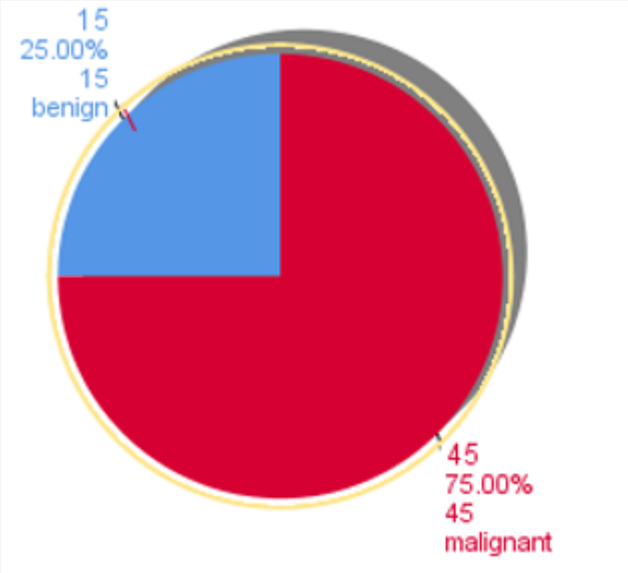
Table 7: Distribution of focal liver masses according to Gender

CASES		GENDER F	GENDER M	Total
	Cholangiocarcinoma	1	2	3
	HCC	8	11	19
	Hemangioma	9	6	15
	metastasis	8	15	23
Total		26	34	60

In our study: Over all, there were 36(60%) males and 24(40%) females in our study, the male to female ratio was 1.5:1. There was male preponderance in HCC (57.8%), Intrahepatic CCA (66.6%) and metastases (65.2%) when compared to females. Most of the cases of Hemangiomas (60%) were seen in females.

Table 8: Distribution of focal liver massesas Benign/ Malignant

Group	Number of cases	Percentage
Benign	15	25%
Malignant	45	75%
Total	60	100%



In our study: Of the total 60 focal liver masses seen , there were 15 benign focal liver masses accounting for about 25%of the total masses and 45 malignant masses accounting for about 75% of the total masses

Table 9: Distribution of focal liver massesas Hypovascular / Hypervascular of the Total cases (n= 60)

Group	**Number**	**Percentage**
Hypovascularmasses	19	31.6%
Hypervascularmasses	40	66.7%
Total	*59	100%

*One lesion demonstrate isovascular appearance

The focal liver masses, based on the enhancement pattern in arterial phase were broadly grouped into, hypovascular or hypervascular masses.

In our study,out of 60 there were 19hypovascularmasses accounting for 31.6% of the total (n=60)masses and 40hypervascularmasses accounting for 66.7%of the totalmasses.

Table 10: Distribution of Hypovascularmasses

Hypovascularmasses	**Number**	**Percentage**
Cholangiocarcinoma	3	15.7%
Hemangioma	2	10.5%

Metastases	14	73.6%
Total	19	100%

Of the 19hypovascularmasses, malignant hypovascularmasses included metastases (n=14) accounting for 73.6% of the total hypovascular masses arising from primary colorectal carcinoma, gastric carcinoma and breast malignancy and CCA (n= 3) accounting 15.7%. The benign hypovascular lesion was Hemangiomas (n=2) comprising 10.5%.

Table11: Distribution of Hypervascularmasses

Hypervascularmasses	**Number**	**Percentage**
Hemangioma	13	34.2%
HCC	19	50%
Metastases	6	15.7%
Total	38	100.00%

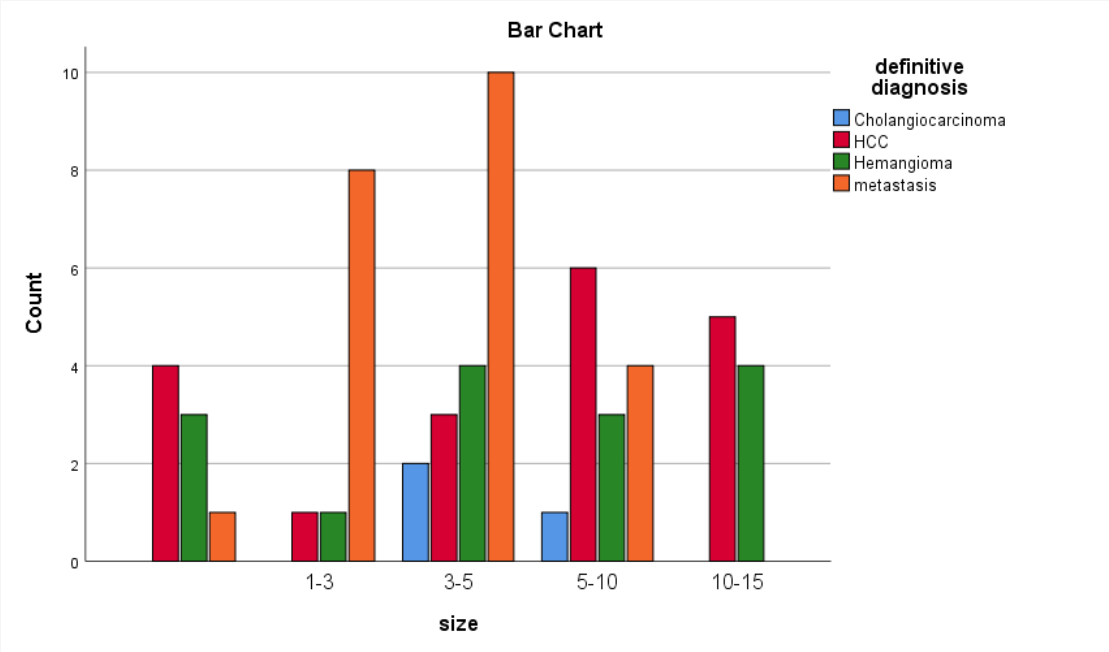
Of the 38 hypervascular masses, Malignant metastatic hypervascular masses were (n=6) 15.7%, from small bowelcarcinoids (n=2),renal cell carcinoma (n=1), and thyroid carcinoma (n=1).

The other hypervascular malignant lesionwas HCC (n=19) accounting 50%. The benign hypervascular lesion included hemangioma (n=13) accounting 34.2%.

Table 12: Size wise Distribution of total masses

Count

		cases			
		Cholangiocarcinoma	HCC	Hemangioma	metastasis
size(cm)	1-3	0	1	1	8
	3-5	2	3	4	10
	>5	1	11	7	4



As per size of the masses

In our study, the masses were grouped as 1-3cm, 3-5cm and >5cm.

10masses were <3cm, 19masses were in the range of 3-5cm and 23masseswere >5cm.

To assess the role of Triphasic liver CT in characterization of masses in our study, data was analysed in two formats:

1. First the patterns of enhancement were compared with the standard of reference to quantify the clinical importance of each of the patterns.
2. Second the abnormalities were compared with their patterns of enhancement to understand the correlation between different pathologic entities and their Triphasic CT appearance

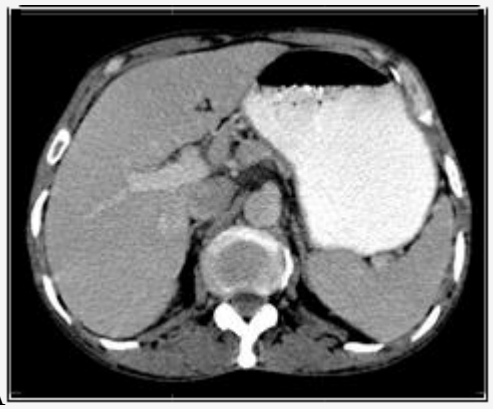
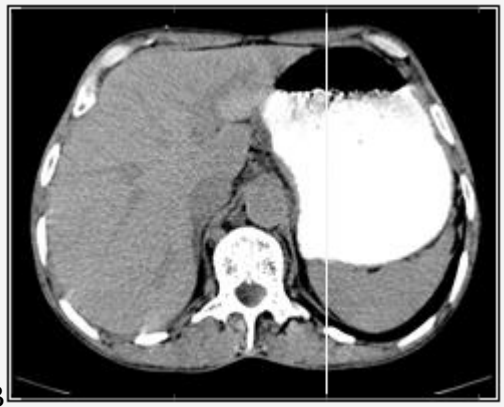
Table 13:Final diagnosis as per Triphasic liver CT

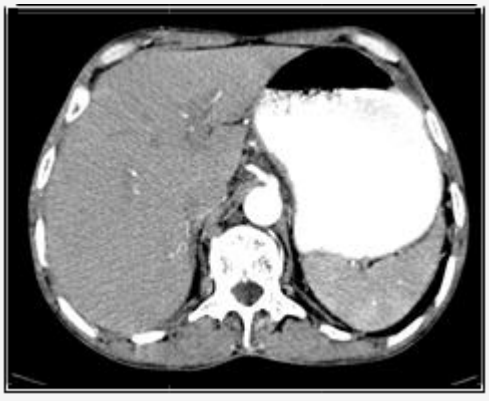
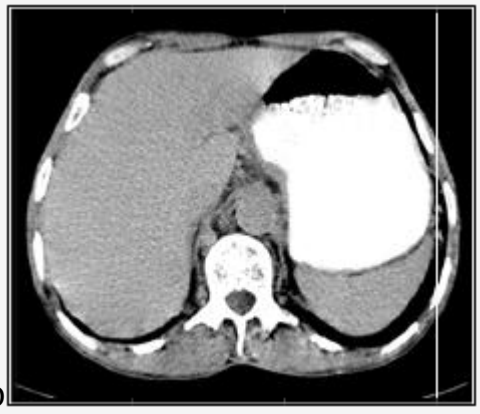
CT Diagnosis	No of patients	Percent (n=60)
Hemangioma	15	25%
HCC	18	30%
Metastasis	24	40%
Cholangiocarcinoma	3	5%

Table 14: Final diagnosis as per Standard of reference

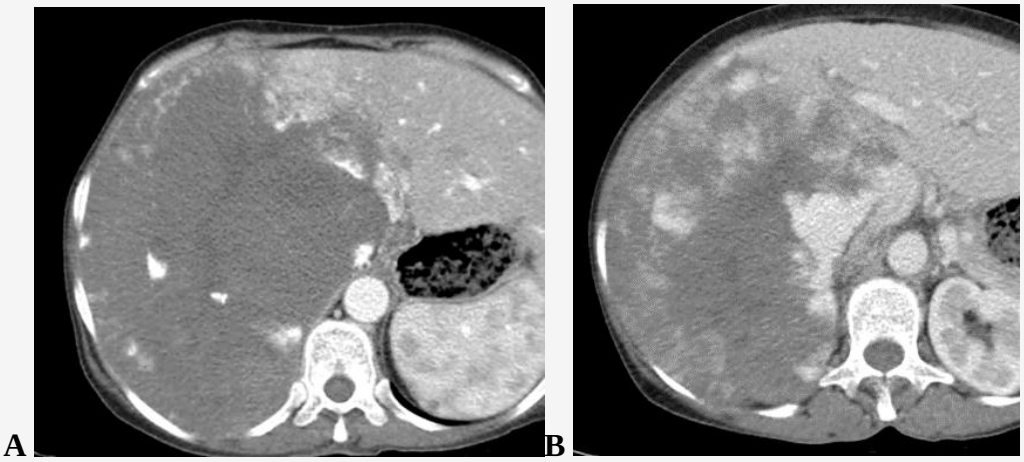
Abnormality	Surgery	Biopsy /FNAC	Follow-up/ Interval growth	Typical imaging findings /AFP	Total(60)
Metastases	0	7		16	23
HCC	2	1		16	19
CCA	1	0		2	3
Hemangioma	0	0		15	15

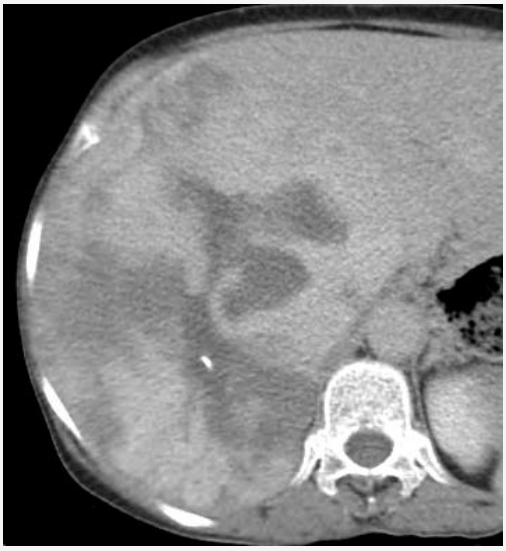
ILLUSTRATIONSOF NORMAL ENHANCEMENT OF HEPATIC PARENCHYMA IN DIFFERENT PHASES

A  B 

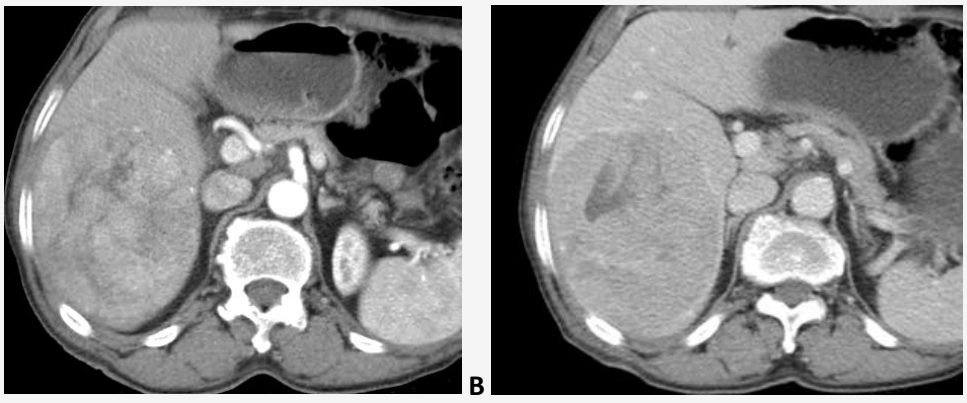
C  D 

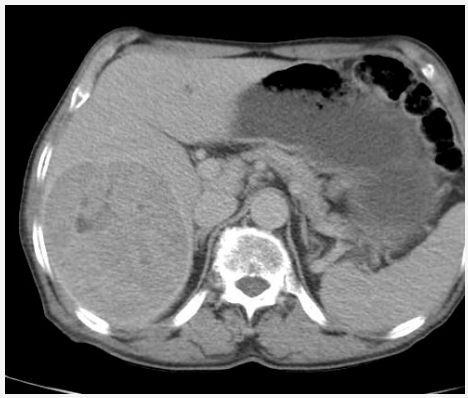
A/ Unenhanced phase B/Hepatic arterial phase (HAP)
C/ portal venous phase (PVP) D/delayed phase (DP)





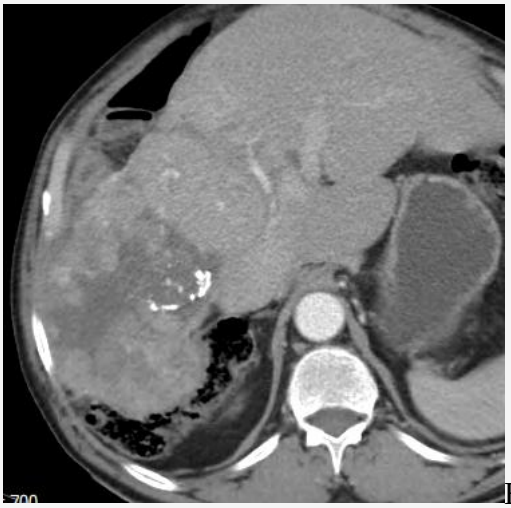
Giant hemangioma in 52years old patientwith characteristic peripheral puddles
A / HAP B / PVP C / DP



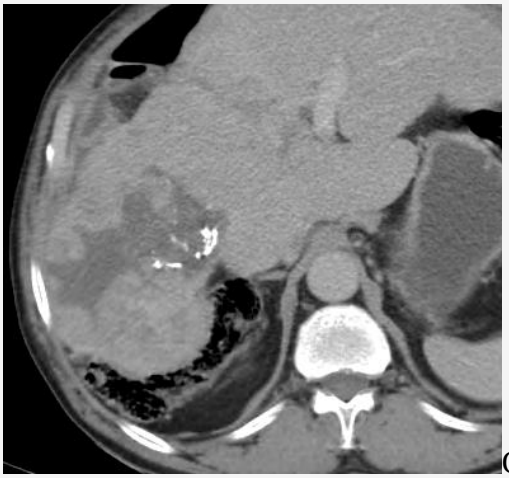


C

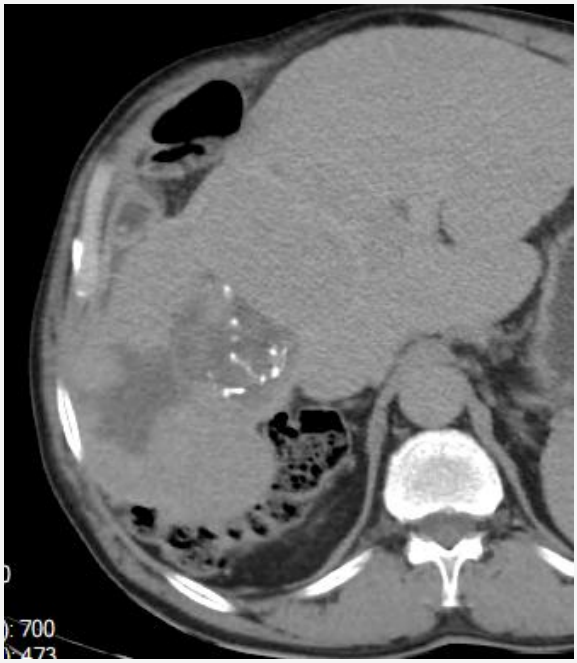
Hepatocellular carcinoma in 78years old man with hypervascular enhancement on arterial phase (A)and relative wash out on (B)PVP and (C)DP. It also demonstrate capsular enhancement on the DP



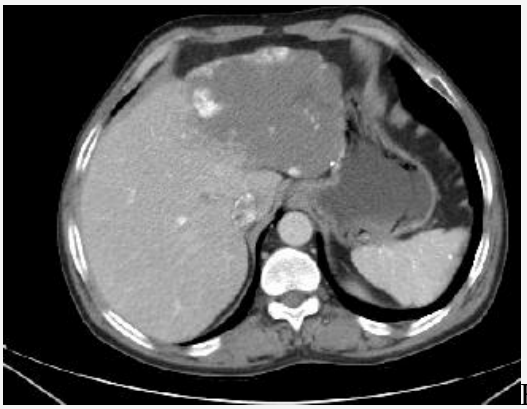
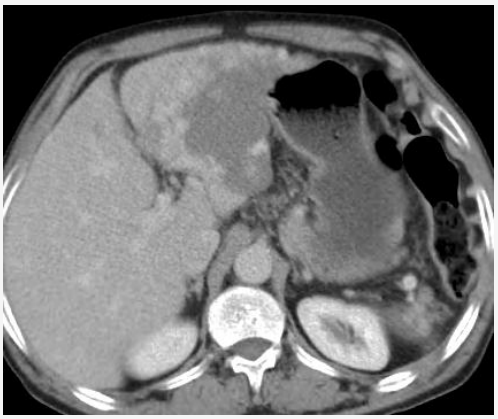
A

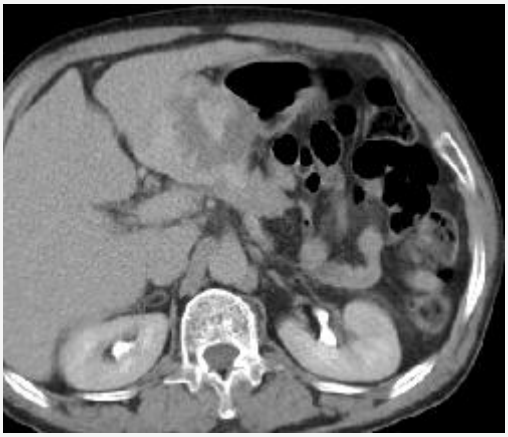


B C

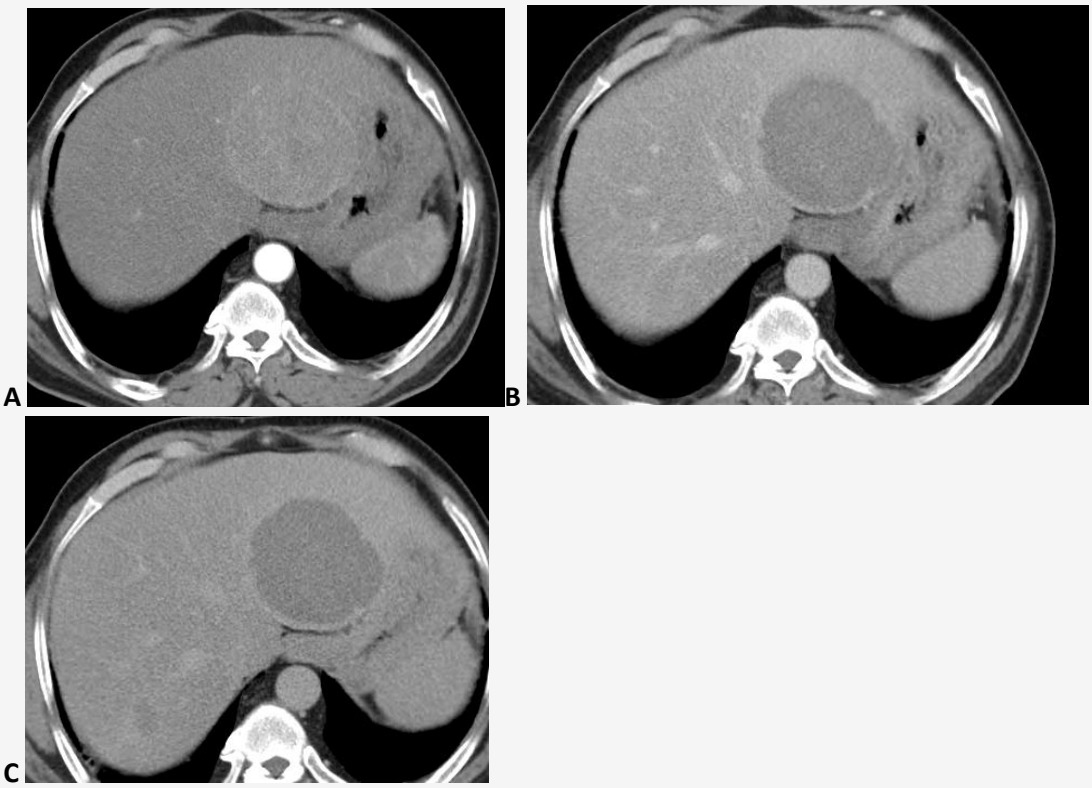


63years old male patient with chronic HCV infection. (A) lobulated heterogeneous mass in the right lobe with central necrosis. Arerial phase predominantly peripheral enhancement with relative subsequent wash out (B) and (C)

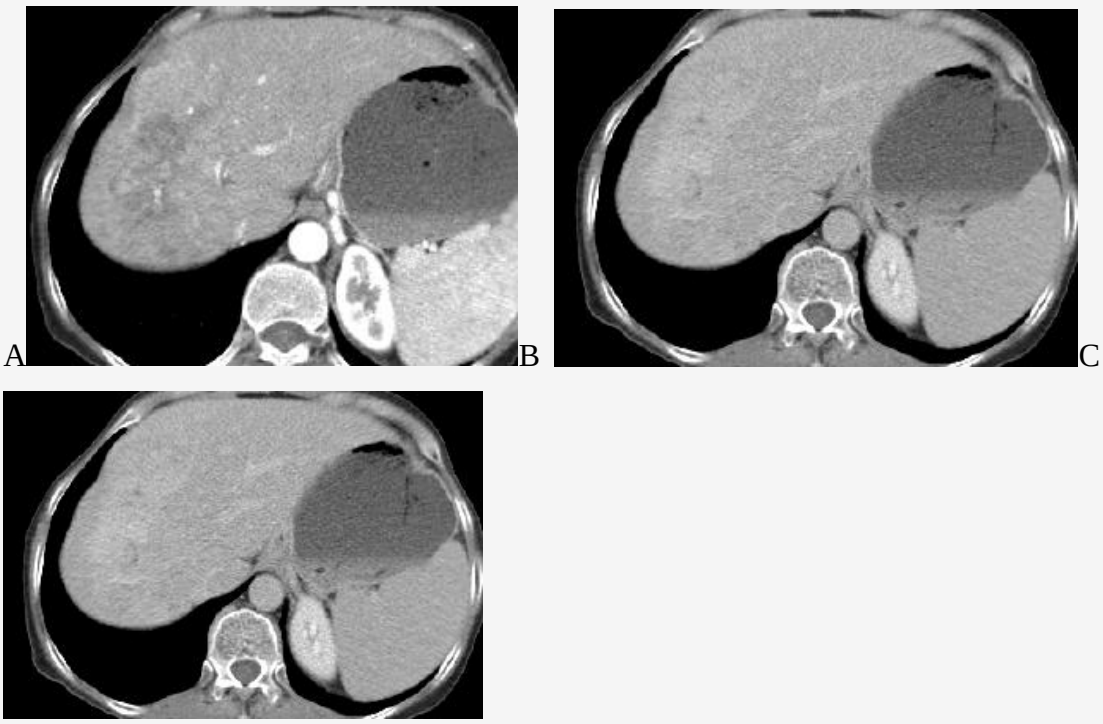
A  B 

C 

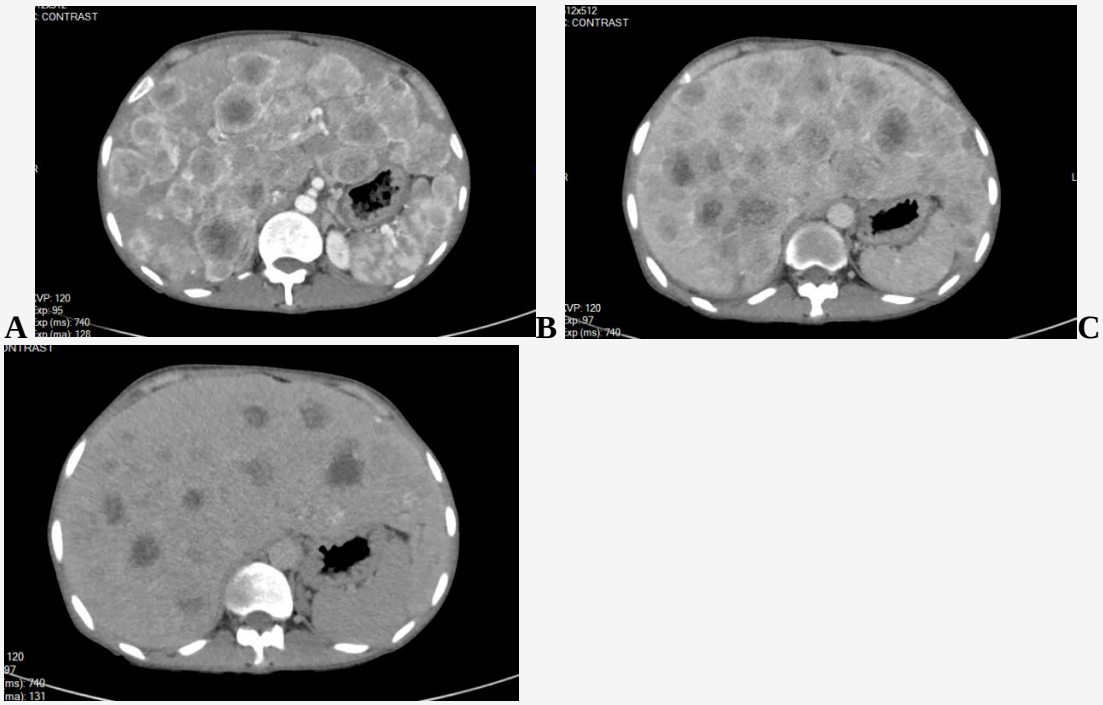
A / HAP B / PVP C / DP
30 year old female patient. Left lobe hemangioma with characteristic globular peripheral enhancement



This is a 64 yesr patient with renal cell carcinoma. On the arterial phase the lesion showed hypervascularity(A) with subsequent wash out on both (B) PVP and (C) DP



60 years old female patient with Cholangiocarcinoma presented with right lobe hypovascular (A) mass lesion with progressive enhancement on subsequent phases (B) & (C)



This is a 52years lod patient with advanced gastric ca. with hypervascular peripherally enhancing (a) and (b)multiple metastatic nodules which shows wash out and becoming isoattenuating to the backgroung liver on dp(c)

Chapter 5: Analysis

DISCUSSION

We conducted a prospective study of 60 patients who underwent Triphasic CT examination for the evaluation of focal hepatic masses. The diagnosis in these patients was obtained either by ultrasound or CT guided FNAC/ biopsy, by typical imaging features, follow up or based on clinical and laboratory findings. Cases, in which final diagnosis was not made by either of the above methods were excluded from the study.

HISTOLOGICAL SPECTRUM:

Our study included 60 patients with hepatic focal masses; most common neoplasm was metastases which accounted for 38.3% of our cases followed by hepatocellular carcinoma which accounted for 31.6% and hemangioma which accounted for 25% of cases. Intrahepatic cholangiocarcinoma accounted for 5% cases.

Cases	**Total No. (60)**	**Bangalore (india) 42 patients**	**Matilde et al (100 patients)**
Hemangioma	15 (25%)	5(12%	32 (30%)
HCC	19 (31.6%)	7(18%)	31 (31%)
Metastasis	23 (38.3%)	22(52%)	39 (37.5%)
Cholangiocarcinoma	3 (5%)	2(3%)	1 (1%)

Matilde et al[30]Studied 100 patients with focal hepatic neoplasm. The most common neoplasm encountered in his study was metastases which accounted for 53% of his cases followed by HCC which accounted for 31% of cases and hemangioma which accounted for 9% of cases. The spectrum of neoplasm encountered in our study correlated with his observations. Another study conducted by **Leeuven et al**[74]of 104 patients showed that metastases formed majority of the cases accounting for 37% which has correlated with our study.

Size of the lesion:

The size of the three major groups of hepatic neoplasm was evaluated in the largest dimensions. In our study, HCC had a size range of 3-20cm with a mean size of 7.3cm. This correlated well with **Matilde et al**[30] who evaluated 31 patients with HCC and found the mean size to be 5.2cm and size range of 1-14.3cm.

Cases	**Our study (N=7)**	**Matilde et al (N=31)**
Hepatocellular carcinoma	3 -20 (7.3cm)	1-14.3 (5.2cm)
Metastasis	1-10 (4.2cm)	1-16.5 (4.9cm)
Hemangioma	1.8-14 (6.4cm)	2-10(4.6cm)

The mean size of metastatic masses encountered in our study was 4.2cm with a size range of 1-10cm. This correlated with **Matilde et al**[30]who studied 53 cases of hepatic metastases and found the mean size to be 4.9cm and a size range of 1-16.5cm.The mean size of hemangioma encountered in our study was 6.4cm with a size range of 1.8-12cm which correlated with **Matilde et al**[30]who studied 9 cases of hemangioma and found the mean size to be 4.6cm and a size range of 2-10cm.

Using a size criterion of 4cm we categorized hemangioma larger than 4cm in size as giant hemangioma. Based on this criterion there were 8 cases of giant hemangioma which accounted for 53.3% of our cases. According to **Adam et al** study group, who considered >4cm size criteria for giant hemangioma.

Hepatocellular carcinoma:

Total 19 patients with HCC were included in our study. Age of the patients ranged from 22-78 years with mean age of 50 years. This correlates with a study conducted by **Richard Baron etal**[33] in which he found a mean age of 58 years and age range of 17- 83 years. **Hwang et al**[32] in his study of 45 patients found a mean age of 52 years and an age range of 31-71 years.

	Our study (7)	**Baron et al (66)**	**Hwang et al (45)**
Age range	22 – 78 years	17 -83 years	31 – 71 years
Mean age	50 years	58 years	52 years
Male : female	5 : 2	51 : 15	39.6

Sex ratio of index is 1.4:1.A higher incidence of HCC has been reported in males by **Baron et al and Hwang et al** study group, with ratio being 51:15 and 39.6 respectively.

Enhancement pattern:

Total 19 cases of HCC were studied for different pattern of enhancement. In arterial phase 16/19masses showed hypervascular enhancement, 84.2% being heterogeneous and 15% homogenous.

Arterial phase	**Our study (N=19)**	**Baron et al (N=66)**	**Junecho Sit et al (N=84)**	**Karahan et al (N=30)**
Hypo	0	14(21.2%)	6%	13 (43%)
Hyper (homogenous)	7 (36.8%)	26 (39.4%)	47%	3 (10%)
Hyper (heterogeneous)	9 (47.3%)	26 (39.4%)	36%)	14 (46%)
Iso	3(15.7%)	0	7%	2 (7%)

Pattern of enhancement on arterial phase in our study was correlating with study conducted by **Baron et al**[33] where 80% of HCC showed hyperattenuation (hypervascular) in arterial phase (39.4% being heterogeneous and 39.4% being homogenous).

Another study conducted by June **Cho Sik et al**[31] included 84 HCCs. Among these 84 patients 83% showed hyperattenuation, 7% were isoattenuating and 6% were hypoattenuating to the liver parenchyma in arterial phase, which is correlating with our study.

In our study characteristic enhancement pattern noted in arterial phase was heterogeneouspattern which accounted for 47.3% of cases.

Porto venous phase	**Our study (N=19)**	**Baron et al (66)**	**June Cho Sik et al (84)**	**Karahan et al (30)**
Hypo	17 (89.5%)	46 (69%)	39%	88%
Hyper	-	13 (21%)	7%	13%
Iso	2(10.5%)	7 (10.2%)	54%	-

In our study group of 19 cases of HCC, pattern of enhancement in portal venous phase were as follows: 89.5% were hypovascular and 10.5% were iso

vascular in enhancement. **June Cho Sik et al**[31] also has reported that around 40% of tumors are hypodense (hypovascular) while he has reported larger percentage of tumors which were isodense on portal phase. According to **Baron et al** 69% of his cases were hypodense, 21% were hyperdense (hypervascular) and 10% were isodense (isovascular). However **Karahan et al**[29] in his study of 30 patients has found a larger proportion of tumours being hypodense on portovenous phase (88%).

In Karahan et al study of 30 HCCs, 17(57%) showed capsule with enhancement in late phase. However in our case we found capsular enhancement in 7 patient corresponding to 36.8% of HCC. June Sik et al[31] also has found a higher percentage demonstrating showing capsular enhancement in equilibrium phase (56%).

Vascular involvement:

	Our study (19)	**Karahan et al (30)**	**Mathieu et al (35)**
Portal vein involvement	12 (63.1%)	15 (50%)	20 (57%)
Hepatic vein	-	10 (33.3%)	-
IVC	-	6 (20%)	-

Portal vein thrombosis(bland + tumor) was noted in 63.1% of our cases which correlates with Karahan et al[29] has reported portal vein involvement in 50% of his cases. **Leeuven et al**[74] however has reported a slightly higher incidence of portal vein involvement (57%). Among 3 cases of portal vein involvement, only 1 (33%) cases showed arterio-portal shunting which is seen in arterial phase but not seen in portal venous phase. According to Baron et al[33] study group of 21 patients with portal vein invasion by tumor, 11(53%) patient showed arterioportal shunting. None of them were visualized in portal venous phase.

METASTASES:

We studied 23 cases of metastatic masses of liver from varying sites. Age group ranged from 35 years to 67 years with mean age being 51 years, which is correlating with two studies conducted by **Leslie et a**l and **Soyer et al**[60] in which mean age was 61 years and 59 years.

	Our study (23)	Leslie et al (47)	Soyer et al (32)
Age range	35 – 67 years	36 – 86 years	29 – 77 years
Mean age	51 years	61 years	59 years
Male : Female	15 : 8	29 : 18	16 : 16

The male to female ratio encountered in our study was 15: 8 compared to ratio of 16: 16 reported by **Soyer et al**[60] and 29: 18 reported by Leslie et al[49].

Spectrum of primary malignancy:

Out of 23 cases of metastases, most common primary was from colorectal malignancy constituting 6 (27%) cases, followed by breast malignancy 3 (9%) stomach and ovarian malignancy. Other causes of secondaries include renal transitional cell carcinoma, thyroid. Our study group spectrum is correlating with **Matilde et al**[30] study, in which 53 metastases were included, majority from colorectal carcinoma (17) followed by pancreatic malignancy (11). Our study group spectrum is also correlating with study group of 58 patients by **Leeuwen et al.** In both studies major contribution was also from other rare primaries for example from retroperitoneal sarcoma, prostatic malignancy, plasmacytoma and lung carcinoma

Site of primary	Our study [N=23]	Matilde et al [53]	Leeuwen et al [58]
Carcinoma rectum / caecum /colon	6 (27%)	17	36
Breastca	3 (9%)	11	3
stomach Ca.	1 (5%)	1	-
ovary Ca	1 (5%)	1	-

ENHANCEMENT PATTERN:

Pattern of enhancement was studied in 23 cases in hepatic metastases. In arterial phase 60.8% showed hypovascular enhancementand21.7% showed peripheral enhancement with only 4.3% showing heterogeneous enhancement.In portal venous phase, 22 (95.6%) were hypovascular and all masses become hypovascular in delayed phase.

Enhancement pattern in arterial phase:

Pattern of enhancement was studied only in arterial phase by categorizing the pattern of enhancement as hypovascular, heterogeneous, homogeneous and peripheral enhancement in relation to the liver. Most common pattern in our study

was hypovascular, accounting to 60.8%%, followed by peripheral rim enhancement pattern accountingfor21.7%.

Arterial phase	**Our study (N=22)**	**Matilde et al (53)**	**Honda et al (28)**
Hypo	14 (60.8%)	4 (7.6%)	17 (60.7%)
Heterogeneous	1 (4.3%)	1 (1.9%)	2 (7.1%)
Peripheral	5 (21.7%)	42 (79.25%)	8 (28.5%)
Iso	3(13%)	6 (11.3%)	1(3.5%)

According to **Honda et al**[34] most common appearance of metastases was hypodensity in arterial phase (60%) followed by peripheral ring enhancement accounting to 28%. In our study also, the same findings is true with hypovascular pattern comprising 60.8% and peripheral enhancement accounting for 21.7%.

Porto venous phase	**Our study (N=22)**	**Honda et al (28)**
Hypo	22 (95.6%)	16 (57%)
Peripheral	0	3 (`10.7%)
Hetero	0	3 (10.7%)
Iso	1(4.3%)	6 (21.4%)

In our study, in portal venous phase majority were hypovascularin appearance accounting to 95.6% followed by isovascular appearance accounting to 4.3%. According to **Honda et al**[34] 57% were hypodense and only 10% showed peripheral enhancement.

HEMANGIOMA

Age group ranged from 21-77 with mean age of 49 years which is correlating with **Yamashita et al (49 years**) and **Leslie et al (58 years**). Females were more affected in our study with ratio being 1.3:1and also in other two studies by **Yamashita et al**[48] and **Leslie et al**[49] incidences was more in females.

	Our study (5)	Yamashita et al (16)	Leslie et al (9)
Age range	21-77 years	24-76 years	33-78 years
Mean age	49 years	49.1 years	58 years
Male: female	1.3:1	5:1	17:27

ENHANCEMENT PATTERN

Total 15 hemangiomas were included, 73.3% showed globular peripheral enhancement in arterial phase and 13.3% showed hypovascular enhancement. In portal venous phase all caseswith globular arterialphase enhancement (73.3%) showed centripetal filling and the rest showed homogenous enhancement.

Our study n-15	**Hypo**	**Uniformly Hyper**	**Peripheral Globular**	**centripetal filling**	**Incomplete late filling**
Arterial	2(13%)	1(6.6%)	11(73.3%)	-	
Portal Venous	-	1(6.6%)		14(93.3%)	
Delayed	-	9(60%)	-	-	6(40%)

Leeuven et al (59)	Hypo	Hyperdense (Globular/ homo)	Iso
Arterial	8(13.6%)	51(86.4%)	-
Portal	8(13.6%)	51(86.4%)	-
Delayed	5(8.5%)	54(91.5%)	-

According to **Leeuven et al**[74] study which included 59 patients, predominant pattern of enhancement was peripheral globular in arterial phase accounting for 86% of cases and portal venous phases accounting to 86% of cases and in the delayed phase 91% were hyperdense. In delayed phase all of the cases were hyperdense to the liver, whereas according to **Leeuven et al**91% of cases showed hyperdense enhancement.

Enhancement pattern in arterial and portal venous phase:

In our study of 15 hemangiomas, 73.3% showed globular enhancement in arterial phase and 13.3% cases showed hypovascular enhancement. These features were correlating with **Kim et al**[46] and **Matilde et al**[30] study, in which globular enhancement in arterial phase was specific for hemangioma accounting to 68% and 66% respectively.

Arterial phase	**Our study (15)**	**Matilde et al (9)**	**Kim et al (37)**
Homogenous(flash filling)	1(6.6%)	1(11.1%)	30%-
Globular	11(73.3%)	6(66.7%)	68%
Incomplete ring	--	2(22.2%)	--
Hypo attenuating	2 (13.3%)	-	2%

Portal venous phase	Our study (15)	Kim et al (37)
Globularenhancement with centripetal filling	80%	49%
Hypo attenuating	-	8%
Isovascular	2(13.3%)	43%

In portal venous phase, our study showed globular enhancement with centripetal filling in 93.3% of cases. According to Kim et al, 49% cases showed globular enhancement with centripetal filing and also 8% of his cases showed hypo attenuation which is not present in ours.

However in his study 43% cases showed isovascularattenuation to the liver whereasonly 6.6% of our cases shows this pattern.

	No. of lesion (15)	Choi et al (10)
Central hypodensity or Incomplete late filling (scar)	6(40%)	10(100%)
Average size of the lesion	7 cm	6cm

Most common pattern of enhancement was globular or peripheral puddling type (PPV- 100%) in arterial phase which was correlating with **Matilde et al**[30] with PPV of 86%. 86.6% of cases showed enhancement which was equivalent to the adjacent vascular enhancement. Central hypodensity in delayed phase was noted in 6masses which could be due to fibrosis or thrombosis.

CHOLANGIOCARCINOMA

We studied 3 cases of cholangiocarcinoma of liver, whose age ranges from 35-65 year old. **Horoshi et al and Yan et al**[56] have reported mean age of 65 years and 66 years respectively in their studied which is on the higher range compared to our study.

Male to female ratio in our study was 3:1 compared to Hiroshi et al and Yan et al who reported a ratio of 11:5 and 9:11 respectively.

ENHANCEMENT PATTERN

Features of intrahepatic cholangiocarcinoma in our study group is hypovascular enhancement in arterial phase with progressive enhancement on portal

venous and delayed phases. Hyperattenuation of tumors in delayed phase is characteristic. Associated intrahepatic biliary dilatation and capsular retraction helps in making diagnosis. These findings were well correlated with **Valls c et al [55] series** of 25 cases and **Hiroshi Honda et al[34]** series of 20 cholangiocarcinoma's. According to these two studies increased CT numbers in delayed phase which is taken after 5-8 min can signify slow diffusion of contrast due to presence of intra-tumoral abundant stroma, which is seen in cholangiocarcinoma. Hiroshi Honda et alalso says that along with these features presence of ancillary findings like lymphadenopathy (69%) can help in diagnosis.

Valls C et al (n-25)	**Iso**	**Hetero**	**Peripheral**	**Hypo**	Progressive enhancement
Arterial	-	4(15%)	14(57%)	7(28%)	-
Portal	-	2(8%)	15(60%)	8(32%)	-
Delayed	9(35%)	-	-	2(8%)	14(57%)

Our study (n-3)	**Iso**	**Hetero**	**Peripheral**	**Hypo**	**Progressive enhancement**
Arterial	-		-	3(100%)	-
Portal	-	-	-	-	3(100%)
Delayed	-	-	-	-	3(100.0%)

Our case had associated intrahepatic biliary radical dilatation, capsular retraction and located peripherally (2) in the sub capsular region. These findings were correlating with **Kim et al** study, who encountered 34 cases of cholangiocarcinoma. Out of 34 cases, 76% showed associated intrahepatic biliary dilatation. However according to his study, only 18% showed capsular retraction, this could be due to disparity in size.

Chapter 6: Summary and Conclusions

"Diagnostic value of Triphasic CT enhancement pattern of focal liver masses" is a hospital based prospective study conducted in the department of Radiology, Addis Ababa University, medical faculty conducted from October 2017 to September 2018. Triphasic MDCT scans were performed in arterial, portal venous and delayed phases after intravenous injection of contrast media. Evaluation of various hepatic masses was done based on the enhancement pattern of the masses and the characteristic imaging features of the masses in different phases.

1. The mean age of incidence of hepatic focal masses were 49.5 years with an age range of 21-78 years. The commonest neoplasms we encountered were hepatocellular carcinoma, metastases and hemangioma.
2. Hepatocellular carcinoma was seen in 19 patients with a mean age group of 50years with male predominance. AFP was found to be elevated in 13 cases.
3. Most common pattern of hepatocellular carcinoma was heterogeneous enhancement in arterial phase with rapid washout in the portal and delayed phase. Arterial phase was better in the detection of lesion as compared to portal venous phase. However combination of both the phases definitely helped in detecting more masses.
4. The mean age for metastasis was 51 years. Most common site of primary was colorectal carcinoma followed by breast and stomachcarcinoma.
5. Most common pattern of enhancement of metastasis was hypovascular enhancement in all three phase, followed by peripheral ring enhancement. Peripheral enhancement was noted in 21.7% of cases in arterial and occasionally in portal venous phase. Portal venous phase was better for lesion conspicuity and detection.
6. Hemangiomas had a mean age of 49 years with Male: Female ratio of 6:9 Common pattern of enhancement was peripheral globular enhancement inarterial phase and progressive centripetal filling in venous and delayed phases.

7. Cholangiocarcinoma showed hypovascular pattern in arterial and some of portal phases with enhancement on delayed phase.Its associated vascular invasion, intrahepatic biliary dilatation and capsular retraction helped in diagnosis.

The Triphasic CT enhancement patterns for HCC were found to be 100% specific and 94.7 sensitive. In metastasis, sensitivity was found to be 100% while specificity is 97.3%. In hemangioma it is 100% sensitive and specific.

The 100% accuracy in diagnosing the cases in our study was one, because of the typical CT appearance in most of the cases we studied and the other can be attributed to the fact that the interpreting radiologists were not blinded from the patient clinical data. 100% sensitivity and specificity for intrahepatic CCA observed in our study was due very small sample size and associated typical findings like vascular invasion, intrahepatic biliary dilatation,extra hepatic lymphadenopathies and capsular retraction may have helped in diagnosis.

Overall Triphasic CT with great accuracy is highly helpful in confident diagnosis of hepatic masses, has an indispensable role in management of both benign and malignant hepatic masses and also helped in reaching primary malignancy diagnosis in cases of multiple liver metastases from unknown primary.

It evaluates the hepatic tumour in the three different phases which in better understanding of the vascular property of the tumor helps in diagnosis as well as management protocol.

Limitation

- Although there was not a histological confirmation in most of the cases, distinctive CT features, stability for 6-12 months and presence/absence of extrahepatic findings, and confirmatory corroborative studies were available in most of the cases to confirm the diagnosis.
- During interpretation radiologist were not blinded from patient data.

STATISTICAL METHODS

Statistical methods applied:

Following statistical methods were applied in the present study:

1. Cross tabs procedure
2. Descriptive statistics
3. Graphical presentation of data

A brief description of each statistical method is given below:

Crosstabs procedure:

The crosstabs procedure forms two-way and multiway tables and provides a variety of tests and measures of association for two-way tables. The structure of the table and whether categories are ordered determine what test or measure to use.

Descriptive statistics:

Provides summary information about the distribution percentages of data is used for comparison.

Graphical presentation of data:

Statistical graphs and diagrams are used for the presentation of data neatly.

Data collection format

Title: ***Focal liver masses: Diagnostic Value of Enhancement Pattern on Triphasic CT at radiology department of Tikur Anbessa specialized hospital, TASH.***

1, Medical record No: - --------- Age ----------Sex----------

2, Clinical data----------

3, Is there a liver lesion? A, No B, yes

- *If yes, how many in number? A,1 B, 2 C, >2*
- *Tumor diameter A, 1-3cm B, 3≤5cm C, >5cm*
- *Which lobe is involved? A, right lobe B, left C, both C, diffuse/infiltrative*

4, what is its enhancement pattern? On arterial phase, portal phase and delayed phase i, on arterial phase

A, No enhancement

B, Peripheral Rim enhancement

C, hypervascular

D, Isovascular

E, Hypovascular

F, Peripheral nodular enhancement

G, other (specify) _____

ii ,portal phase

A, No enhancement

B, Peripheral Rim enhancement

C, hypervascular

D, Isovascular

E, Hypovascular

F, progressive centripetal filling

G, other (specify) _____

iii, delayed phase

A, No enhancement

B, Peripheral Rim enhancement

C, hypervascular

D, Isovascular

E, Hypovascular

F, progressive centripetal filling

G, other (specify) _____

5, Is there a portal or delayed phase washout? A, yes B, No C, not sure

6,does the lesion have a capsule, which enhance in the portal/delayed phase?

A,yes B, no C, not sure

7, how is the margin of the lesion? A, well defined B, ill defined

8, Is there capsular retraction? A, yes B, No

9,Is there portal vein invasion or extra hepatic metastasis? A, yes B, no C, not sure

10, If prior image is ≤6 months, does the lesion diameter increase by ≥50%? A, yes B, no

11, If prior image is >6 months, does the lesion diameter increase by ≥100%? A, yes B, no

12, Is the background liver cirrhotic? A, yes B, no C, not sure

13, Does the patient test positive for AFP? A,yesB,no

14, Is the patient test positive for hepatitis B or C? A,yes B, NO

15, what is your radiological diagnosis or differential diagnosis?

_____

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patient ID	age(YRS)	sex	presenting complaints	definitive diagnosis	CT diagnosis	type of examination	precontrast	arterial phase	portal phase	delayed phase	cirrhosis	capsule	PVTI/ invasion	number of lesions	Location	Margin	size	Interval growth	prior imaging AUS or	laboratory results (AFP)	pathology	Malignant or Benign	REMARK
517404	67	M	r/o HCC	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense/heterogeneous	Globular peripheral,f sadens	Centripetal progressiv	Incomplete fill-in/isadens	NO	NO	NO	multiple		well defi	11.8 cm	NO	YES	negative	NO	benign	peripheral foci of calcification and stabl
514255	36	F	T2DM,Fatty liver,	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Hypovascular	Hypovascular	Isovascular	NO	NO	NO	solitary		well defi	7.5 cm	NO	YES	negative	NO	benign	
525399	50	F	?	Cholangiocarcino	Cholangiocarcino	Triphasic abdominal CT	heterogrnuous/hypodens	**Hypovascular with peripher**	progressive enhancer	progressive enhancement	NO	NO	YES	solitary	right lobe	well defi	12cm		YES	negative	NO	malignant	
29133	50	F	RVI	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	peripheral hypervasc	peripheral hypervascular	NO	NO	NO	multiple	Both								
516226	45	M	RUQ pain and abd	HCC	HCC	Triphasic abdominal CT		homogenous hypervascular	washout	washout	Yes	NO	YES	multiple	right lobe	ill defined			YES	Positive		malignant	
24892	35	M	?HCC	HCC	HCC	Triphasic abdominal CT	iso to hypodense	Heterogeneous hypervascul	washout	washout	Na	NO	YES	multiple	Left lobe	well defi	13.28 cm	YES	YES	Positive		malignant	
523903	55	F	cancer of unknow	metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	hypovascular	NO	NO	NO	multiple	Both	well defined		YES	YES	negative		malignant	lung nodular lesions suggestive for met
13755	42	M	HCC	HCC	HCC	Triphasic abdominal CT		Heterogeneous hypervascul	washout	washout	NO	YES	NO	multiple	right lobe	ill defined	9.8 cm	YES	YES	Positive		malignant	
507422	**30**	**F**	**Advanced ovarian**	**Cholangiocarcino**	**Cholangiocarcino**	Triphasic abdominal CT	**hypodense**	**Hypovascular**	**Hypovascular**	**progressive enhancement**	**NO**	**NO**	**YES**	**solitary**	**left lobe**	**ill defined**			**YES**	**negative**		**malignant**	**marked atrophy of the left lobe of the l**
517579	65	M		Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Globular peripheral,f sadens	Centripetal progressiv	Complete fill-in/isodense	NO	NO	NO	multiple	Both		10 cm	NO	YES	negative		benign	stable on follow up
471087	60	F	Neuroendocrine t	HCC	metastasis	Triphasic abdominal CT		Heterogeneous hypervascul	washout	washout	NO	NO	NO	multiple	right lobe	ill defined		YES	YES	Positive	YES	malignant	Neuroendocrine tumor most likely aris
488733	47	M	left lung cancer p	metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	Hypovascular	NO	NO	NO	solitary	left lobe	well defi	3CM	YES		negative		malignant	Left lung cancer post pneumonectomy f
460877	31	M	Hemangioma RO I	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Hypovascular	Centripetal progressiv	Complete fill-in/isodense	na	NO	NO	multiple	Both	well defi	2.7 cm	NO	YES	negative		benign	stable on follow up
518884	52	F		Hemangioma	Hemangioma	Triphasic abdominal CT	heterogeneous	Globular peripheral,f sadens	Centripetal progressiv	Incomplete fill-in/isadens	NO	NO	NO	solitary	**right lobe**	well defi	18 cm	NO	YES	negative		benign	Stable on follow up
575830	30	M	CLD R/O HCC	HCC	HCC	Triphasic abdominal CT		Heterogeneous hypervascul	washout	washout	Yes	NO	YES	multiple	Both	ill defined		YES	YES	Positive		malignant	Also isodense on arterial and hypoatten
3498	40	F	Hepatic mass secc	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Globular peripheral,f sadens	Centripetal progressiv	Complete fill-in/isodense	NO	NO	NO	multiple	right lobe	well defi	4cm					benign	
453003	63	F	Known CLD,Hep B	HCC	HCC	Triphasic abdominal CT	heterogenous	Heterogeneous hypervascul	washout	washout	Yes	NO	NO	multiple	Both		5.3 cm	NO	YES	negative		malignant	there are also isoattenuating lesion wit
504931	**46**	**F**		**HCC**	**HCC**			**Heterogeneous hypervascul**	**washout**	**washout**	**Yes**		**YES**	**Multiple**	**Both**	**well defined**							
309378	42	F	Hemangioma RO I	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Globular peripheral,f sadens	Centripetal progressiv	Complete fill-in/isodense	NO	NO	NO	multiple	Both	well defi	4.5 cm	NO	YES	negative		benign	KNOWN CASE AND STABLE FOR OVER 6
517579	65	M	BOO 2y to BPH RC	Hemangioma	Hemangioma	Triphasic abdominal CT		Globular peripheral,f sadens	Centripetal progressiv	Complete fill-in/isodense	na	NO	NO	solitary		well defi	10 cm	NO	YES	negative		benign	stable on follow up
518926	60	M	R/O HCC	HCC	HCC	Triphasic abdominal CT	hypodense	Heterogeneous hypervascul	washout	washout	NO	NO	YES	multiple	Both	ill defined			YES	Positive		malignant	heterogeneously enhancing on arterial
519744	45	F	?Advanced colore	metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	Hypovascular	NO		NO	multiple	Both	ill defined	8cm	YES		negative		malignant	COLON
51892	45	M	Oi 2ry to periampu	Cholangiocarcino	Cholangiocarcino	Triphasic abdominal CT	hypodense	Hypovascular	progressive enhancer	progressive enhancement	NO	NO		solitary		ill defined			YES	negative		malignant	moderate symmetrical intrahepatic bili
519248	63	M	HCV infected, R/O	HCC	HCC	Triphasic abdominal CT	heterogenous	homogenous hypervascular	washout	washout	Yes	YES	YES	solitary	right lobe	ill defined			YES	Positive		malignant	calcification
519327	60	F	RUQ pain 20 yrs,	Hemangioma	Hemangioma	Triphasic abdominal CT	HYPODENSE	Globular peripheral,f sadens	Centripetal progressiv	Complete fill-in/isodense	NO			multiple	Both	well defi	6.5cm,	NO	YES	negative		benign	stable
517790	31	M	RO HCC	HCC	HCC	Triphasic abdominal CT		homogenous hypervascular	washout	washout	Yes	YES	NO	multiple	Both	well defi	6.3 cm	YES	YES			malignant	multiple periportal enlarged lymph noc
14877	42	M	Presented with h	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Globular peripheral,f sadens	Centripetal progressiv	Complete fill-in/isodense	NO	NO	NO	multiple	Both	well defi	4.9cm	NO	YES	negative		benign	stable
445631	34	M	Segmentectomy x	HCC	HCC	Triphasic abdominal CT		hypervascular enhancement	washout	washout	Yes	NO	YES	multiple	Both	ill defined	7.7cm	YES	YES			malignant	thrombosis
22182	45	M	Right lobe liver m	HCC	HCC	Triphasic abdominal CT		homogenous hypervascular	washout	washout	Yes	NO	YES	solitary	Right lobe		20cm	YES		Positive		malignant	
482642	60	M	HCC on follow up;	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	peripheral hypervascular	hypervascular enhanc	Isovascular	NO	NO	NO	solitary	left lobe	well defined		NO	YES	negative		benign	stable
14466	45	M	Liver mass sec to	HCC	HCC	Triphasic abdominal CT		peripheral hypervascular	washout	washout	NO	NO	NO	multiple	Both	ill defined		YES		Positive		malignant	some wash out on PVP and most lesio
526766	77	M	Leimyosarcoma d	metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	Hypovascular	NO	NO	NO	solitary	right lobe	well defi	8cm	YES		negative		malignant	
484865	38	M	Stage IV rectal ca	metastasis	metastasis	Triphasic abdominal CT	hypodense	Hypovascular with periphery	Hypovascular	Hypovascular	NO	NO	NO	multiple	Both	well defi	2.5	YES		negative		malignant	
529495	47	M		Cholangiocarcino	Cholangiocarcino	Triphasic abdominal CT		Hypovascular	progressive enhancer	progressive enhancement	NO	NO	YES	solitary		well defi	8.5cm		YES	negative		malignant	capsular retraction of the liver.
491191	57	F	NHL post 6 cycles	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Globular peripheral,f sadens	Centripetal progressiv	Complete fill-in/isodense	NO	NO	NO	solitary		well defined		NO	YES	negative		benign	compared with previous film no interv
525780	73	M	Multiple liver lesi	metastasis	metastasis	Triphasic abdominal CT		Heterogeneous hypervascul	Heterogeneous hyper	Hypovascular	NO	NO	NO	multiple	Both	well defi	4cm	YES		negative		malignant	
499385	60	F	HCC for surgical n	HCC	HCC	Triphasic abdominal CT		Heterogeneous hypervascul	washout	washout	Yes		YES	multiple	Both	well defi	17.4cm	YES	YES	Positive		malignant	central areas of hypoattenuating prob
517503	26		Multiple hypo de	metastasis	metastasis	Triphasic abdominal CT	hypodense	Heterogeneous hypervascul	Heterogeneous hyper	Hypovascular	NO		NO	multiple	Both	well defi	5.6cm	YES		negative		malignant	
486826	44	M	cancer of unknow	metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	Hypovascular	NO	NO	NO	multiple	Both	well defi	7cm	YES		negative		malignant	CUO...BIOPSY SECONDARY ADENOCAR
25437	35	M	?HCC	Cholangiocarcino	Cholangiocarcino	Triphasic abdominal CT	hypodense	Hypovascular	progressive enhancer	progressive enhancement	NO	NO	YES	solitary	right lobe					negative		malignant	
88888888	40	M		Hemangioma	Hemangioma			Globular peripheral,f sadens	Centripetal progressiv	f/sadense to vessels	NO	NO	NO	Multiple	Both	well defined							
527194	27	F	Breast cancer to r	metastasis	metastasis	Triphasic abdominal CT	hypodense	Heterogeneous hypervascul	Heterogeneous hyper	Hypovascular	NO	NO	NO	multiple	Both	well defi	1.5	YES		negative		malignant	
503672	60	M		metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	Hypovascular	NO		NO	solitary	right lobe	well defi	4.5 cm			negative		malignant	GASTRIC
10262	21	M	RUQP	HCC	HCC	Triphasic abdominal CT		homogenous hypervascular	washout	washout	Yes	NO	YES	solitary	right lobe	ill defined			YES	Positive		malignant	multiple smaller satellite lesions
518412	68	F		HCC	HCC	Triphasic abdominal CT	heterogenous	homogenous hypervascular	washout	washout	Yes	NO	YES	multiple	left lobe		12 cm		YES	Positive		malignant	necrosis/hemorrhage multiple discre
9547	40	F	Breast ca patient	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	Hypovascular	Hypovascular	NO	NO	NO	multiple	Both	well defi	3cm			negative		malignant	BREAST
530426	45	M		HCC	HCC	Triphasic abdominal CT	heterogenous	Heterogeneous hypervascul	washout	washout	NO	NO	YES	multiple	right lobe	ill defined		YES	YES			malignant	
9523	85	M	r/o gastric ca	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	Hypovascular	Hypovascular	NO		NO	multiple	Both	ill defined	1.8			negative		malignant	GASTRIC
507870	52	M	Underwent right p	HCC	HCC	Triphasic abdominal CT		homogenous hypervascular	washout	washout	Yes			multiple	Both	ill defined		YES	YES	Positive	YES	malignant	Underwent right posterior segmentecto
95661	64	M	RO HCC	metastasis	metastasis	Triphasic abdominal CT		homogenous hypervascular	washout	Na	YES	NO		multiple	Both	well defi	6.5cm	YES	YES	negative		malignant	The left kidney is not visualized(Tpost r
522557	60	F	liver mass	Cholangiocarcino	Cholangiocarcino	Triphasic abdominal CT	hypodense	Hypovascular with periphery	progressive enhancer	progressive enhancement	NO		NO	solitary	right lobe	ill defined				negative		malignant	
517508	60	F	Massive ascites 2	HCC	HCC	Triphasic abdominal CT	heterogeneous	Heterogeneous hypervascul	washout	washout	Yes	YES			left lobe	well defi	11cm			Positive			
506368	46	F		metastasis	metastasis	Triphasic abdominal CT		hypervascular	washout	washout			YES	solitary	Left lobe	ill defined	2.7 cm			negative		malignant	SMALL BOWELL TUMOR
506404	21	M	lung cancer r/o liv	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	Hypovascular	Hypovascular	NO	NO	NO	multiple	Both	ill defined	7cm			negative		malignant	
518634	47	M	?Hemangioma, R/	Hemangioma	Hemangioma	Triphasic abdominal CT	hypodense	Globular peripheral,f sadens	Centripetal progressiv	f/sadense to vessels	NO	NO	NO	multiple	Both	well defi	4cm	NO	YES	negative		benign	stable
516876	60	M	loss of appetite +	metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	Hypovascular	NO	**NO**	NO	multiple	Both	well defi	8cm	YES		negative		malignant	advanced right retroperineal mass
88888888	30	F	**RXR h/breast ca**	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	peripheral hypervasc	Hypovascular	NO	NO	NO	multiple	Both								
506279	**48**	**F**	**ADVANCED RECTA**	**metastasis**	**metastasis**	Triphasic abdominal CT	hypodense	**Hypovascular**	**Hypovascular**	**Hypovascular**	**NO**		**NO**	**multiple**	**Left lobe**	**well defi**	**1.5**			**negative**		**malignant**	
473412	63	F	SMALL BOWELL C	metastasis	metastasis	Triphasic abdominal CT		enhancement	washout	washout	NO		YES	solitary	Left lobe	ill defined	2.7 cm			negative		malignant	SMALL BOWELL CARCINOID
482205	37	M		metastasis	metastasis	Triphasic abdominal CT		Hypovascular	Hypovascular	**Isovascular**	NO		NO	multiple	Both	well defi	1.5cm	YES		negative		malignant	BREAST
540069	65	F	Easy fatigabilit	Cholangiocarcino	Cholangiocarcino	Triphasic abdominal CT	hypodense	Hypovascular	progressive enhancer	progressive enhancement	NO	NO	YES	solitary		ill defined	12.5			NE		malignant	
525214	47	F		metastasis	metastasis	Triphasic abdominal CT		Hypovascular	washout	washout			YES	solitary	Left lobe	ill defined	2.7 cm			negative		malignant	
503025	52	F	GASTRIC CA	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	**washout**	**washout**	**NO**	**NO**	**NO**	multiple	**Both**		small						
512239	66	M		HCC	HCC	Triphasic abdominal CT		homogenous hyperenhance	washout	washout	Yes	NO	YES	multiple				YES	YES	Positive	NO	malignant	Portal vein Thrombosis
502786	64	M	RCC operated 9 yr	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	**washout**	**washout**	**NO**	**NO**	**NO**	multiple	**Both**		big mass						RCC
21803	38	M	GASTRIC CA	metastasis	metastasis	Triphasic abdominal CT		peripheral hypervascular	washout	washout	NO	NO	NO	solitary	Right lobe	well defined							
28257	F			HCC		Triphasic abdominal CT		enhancement	washout	washout				multiple	Both							malignant	
28091	60	F		metastasis	metastasis			Heterogeneous hypervascul	Hypovascular	Hypovascular	NO	NO	NO	multiple	Both		10cm						?GASTRIC