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Spectrum Of Findings On Triple Phase CT In Patients With Focal Liver Lesions

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Abstract

Objectives:

1. To analyze/evaluate enhancement pattern of liver lesions in various phases.
2. To classify/differentiate liver lesions into benign or malignant.
3. To establish the diagnosis of various hepatic masses based on the features seen on triple-phase multidetector computed tomography.
4. To correlate the radiological findings of triple-phase multidetector computed tomography with clinical and cyto-histopathology findings wherever indicated.

Method:

Place of study: Mata Chanan Devi Hospital, New Delhi. The source of data: Cases of suspected liver disease who have undergone triphasic CT for evaluation of liver lesions in the department of radiodiagnosis, Mata Chanan Devi Hospital, New Delhi.

Study design:

Observational cross-sectional study. Sample size: 40 patients.

Calculations:

Statistical analysis: Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. The normality of data was tested by the Kolmogorov-Smirnov test. If the normality was rejected then non-parametric test was used.

Result:

The present study was planned to characterize various hepatic lesions with the help of a triple-phase multidetector CT scan. Subsequently, correlation of these characteristics was done with histopathological/ cytopathological findings and final diagnosis. Based on triphasic CT assessment, a total of 21 out of 40 (52.5%) patients were diagnosed as malignant and the remaining 19 (47.5%) were diagnosed as benign. Among benign lesions – 11(27.5%) were diagnosed as hemangiomas, 4(10%) were hepatic abscesses and 2(5%) were simple cysts. Hepatic adenoma and F.N.H contributed 1(2.5%) each. Among malignant masses, metastasis was most commonly seen in 12(30%) cases. Hepatocellular carcinoma was diagnosed in 7(17.5%) cases. Among the metastasis, carcinoma gall bladder metastasis was
seen in 2 cases, followed by carcinoma lung metastasis (n=3), unknown primary (n=4; 10.9%), carcinoma breast metastasis (n=1), carcinoma colon metastasis (n=1;). There was one case of
metastases from R.C.C.

Conclusion:

The present study was planned to characterize various hepatic lesions with the help of a triple-phase multidetector CT scan. Subsequently, correlation of these characteristics was done with histopathological/cytopathological findings and final diagnosis. For this purpose, a total of 40 patients with hepatic lesions were assessed and analyzed using triple-phase multidetector computed tomography followed by histo-cytopathological evaluation for confirmation. Based on triphasic MDCT evaluation, malignant etiology was established in 20/40 (50.0%) of cases – including 6 (15%) cases diagnosed as hepatocellular carcinoma, 14(35%) cases diagnosed as metastatic lesions. Benign etiology was established in 20/40 (50%) patients – including 11(27.5%) cases diagnosed as hemangioma, 4(10%) cases of abscesses, 2(5%) of simple cysts and 1(2.5%) each of adenoma, F.N.H and hepatic regenerative nodule. On correlating the triple phase MDCT findings with clinical profile of patients, Older age, and male gender were significantly associated with triphasic MDCT diagnosed HCC and metastases. On triphasic CT, in arterial phase, intense or heterogeneous enhancement followed by washout in PV phase were the characteristic findings of HCC. Metastatic lesions either had no enhancement or less frequent intense enhancement in arterial phase, peripheral enhancement in PV phase and absence of enhancement in delayed phase as the characteristic findings whereas in benign lesions hemangiomas were characterized by centripetal filling in successive phases, peripheral wall enhancement in arterial phase in hepatic abscess, no enhancement in simple cysts and heterogenous intense enhancement in arterial phase in F.N.H and adenoma. The results of this study prove MDCT to be highly sensitive in sorting the hepatic lesions into clinically relevant categories which helps in achieving correct diagnosis and evaluation of lesion.

Keywords: Liver lesions, 64-slice CT scanner, Triphasic CT, Hepatocellular carcinoma

Introduction

The liver is an important constituent of the digestive tract and is involved in the maintenance of the body's metabolic homeostasis. Due to its major function of detoxification of the body and its rich blood supply by hepatic artery and portal vein, it becomes prone to various diseases [1]. Any lesion in the liver of any size other than the normal hepatic parenchyma with or without causing structural and functional abnormality of the hepatobiliary system is known as a focal liver lesion [2]. These focal lesions can be classified as benign or malignant. Different geographic and ethnic groups share different prevalence of these lesions [3]. Liver cancer is a major cancer in less developed countries where 83% of worldwide incidence of new cases has been reported with China alone accounting for nearly 50% of new incident cases of liver cancer [4]. As per an estimate about 7 Lakhs death due to hepatocellular carcinoma (HCC) occur annually [5]. In India, the incidence rate of hepatocellular carcinoma ranges from 0.7 to 7.5 and 0.2 to 2.2 per 1,00,000 population per year for men and women respectively [6]. Fortunately, liver masses are increasingly being identified due to the widespread use of imaging modalities such as ultrasonography (USG), computed tomography (CT), and magnetic resonance imaging (MRI). The majority of these lesions are detected incidentally in asymptomatic patients. An accurate history and physical examination are essential to the diagnosis and treatment of solid liver masses [7]. Although most incidentally noted liver masses are benign yet it may be difficult to differentiate benign hepatic lesions from those that are malignant. Furthermore, some benign lesions have malignant potential. Certain lesions such as focal nodular hyperplasia (FNH), hemangiomas and focal steatosis are often distinctly diagnosed by an imaging modality alone. In effect, diagnosis of focal liver lesions is a challenging task in clinical settings [8]. Accurate characterization of liver masses by cross-sectional imaging is particularly dependent on an understanding of the unique phasic vascular perfusion of the liver and the characteristic behaviors of different lesions during multiphasic contrast imaging [9]. With the increasing availability of computed tomography and owing to its relatively lower cost to the patient, it has become one of the

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most popular advanced imaging tools. It is a continuously evolving modality that has seen transition from a cross-sectional technique to spiral (helical) CT and subsequently transformed from a two-dimensional into a true volumetric imaging modality [10]. A second revolution occurred when multi-slice (multidetector-row) CT (MDCT) was introduced [11]. Multi Detector CT, based on a four-row configuration of detectors, together with the development of sub-second gantry rotation time, offered the opportunity to overcome common limitations of single-slice CT scanners, especially in terms of scanning time and limited z-axis resolution [12]. Technical evolution was followed by the development of 8- and 16-slice scanners, which became available between 2001 and 2002, and continued with the 64-slice equipment in 2003 [13]. Other benefits of CT are easy access due to wide availability and patient-friendly protocols allowing even a chest–abdomen–pelvis CT examination in a less than 20-second breath hold using multidetector CT technology [14]. Spiral computed tomography has gained acceptance as the preferred technique for the evaluation of a wide range of liver lesions because it provides image acquisition at peak enhancement of liver parenchyma in a single breath hold reducing the chances of missing small lesions [15]. Triphasic Spiral computed tomography technique allows imaging of the entire liver in three phases from the time of administration of contrast. The first phase is the hepatic arterial phase which enables early identification of primary malignancy of the liver (hepatocellular carcinoma) and benign lesions (such as hemangioma focal nodular hyperplasia and hepatocellular adenoma). The second phase is the portal venous phase which is the most sensitive phase to detect some hypervascular tumors (hepatocellular carcinoma, metastatic melanoma, etc.) and most of the hypovascular tumors of the liver such as metastatic lung carcinoma, metastatic colon cancer and metastatic breast cancer. The third phase is the hepatic venous phase also known as the equilibrium phase along with the hepatic arterial phase gives information on the vascularity of the lesion, which may further help to clarify the nature of the lesion [16]. Hence, the purpose of the study is to characterize a wide range of liver lesions using triphasic spiral computed tomography.

Aim:

The present study was carried out with an aim to characterize various hepatic lesions with the help of triple phase multidetector CT scan and to correlate them with histopathological/cytopathological findings.

MATERIAL AND METHODS:

Place of study: Mata Chanan Devi Hospital, New Delhi.

The study was approved by the institutional ethical committee.

The source of data: Cases of suspected liver disease who have undergone triphasic CT for evaluation of liver lesions in the department of radiodiagnosis, Mata Chanan Devi Hospital,

New Delhi will be included in this study.

Study design: Observational cross-sectional study.

Sample size: 40 patients.

The study of Shreshtha Jain, et al observed that the most common diagnosis was an abscess (45.24%) followed by cysts (11.90%) and haemangioma (15.48%). Taking this value as reference, the minimum required sample size with a 10% margin of error and 5% level of significance is 96 patients. For a finite sample size taking population as 60, the total sample size calculated is 38. To reduce the margin of error, the total sample size taken is 40.

The formula used is: -

1) $SS \geq (p(1-p))/(ME/z\alpha)^2$

2) $N >= SS/(1 + [(SS - 1)/Pop])$

Where $Z\alpha$ is value of Z at two-sided alpha error of 5%, ME is the margin of error p is the proportion of patients with various diagnoses. Pop is population

Calculations:

1) Abscess

$SS>=((.4524*(1-.4524))/(.1/1.96)^2=95.17=96$(approx.)

2) Cyst

$SS>=((.1190*(1-.1190))/(.1/1.96)^2=40.27=41$(approx.)

3) Haemangioma

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SS>=((.1548*(1-.1548))/(.1/1.96)^2=50.26=51(approx.)

n>=96/(1+(96-1)/60)=37.16=38(approx.)

Statistical analysis: Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. The normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected then non-parametric test was used.

Statistical tests were applied as follows-

1. Quantitative variables were compared using Independent t-test (when the data sets were not normally distributed) between the two groups and ANOVA between more than two groups.
2. Qualitative variables were correlated using Chi-Square test/Fisher's Exact test.
3. Diagnostic test was used to calculate sensitivity, specificity, NPV and PPV.
4. Inter-rater kappa was used to find out the strength of agreement between MDCT and cyto-histopathology.

A p-value of <0.05 was considered statistically significant.

The data was entered in an MS EXCEL spreadsheet and analysis was done using Statistical

Package for Social Sciences (SPSS) version 21.0.

Study Duration: Nine Months

Methodology

Inclusion criteria:

1. Patients of any age group.
2. Patients with suspected/proven focal liver lesions by other imaging modalities.

Exclusion criteria:

1. All pregnant women.
2. All patients with hypersensitivity to CT contrast agents, renal impairment, all restless patients and patients in whom CT is contraindicated due to any other reason.

Method Of Data Collection:

Equipment used:

1. Philips ingenuity 64-slice CT SCANNER.
2. Automatic pump injector.

Patient preparation: When patient presented for abdominal CT scan, assessment of clinicalproblems and a review of previous imaging studies was carried out.Assessment of medical history includes the current indication for study, contrast allergies, renalimpairment, post-abdominal surgeries, pregnancy tests for females etc.Patient positioning: Patients were positioned in supine position with feet first, center betweenxiphoid process to iliac crest. The longitudinal alignment lies in the midline and the horizontalone passes just below the lower costal margin.Contrast used: IOHEXOL (OMNIPAQUE 300mg I/ml) 100ml in adults and 1-3ml/kg inchildren is given by an automated injector at the rate of 3.5-4ml/sec through a 16-18G cannula.Scans obtained:• All examinations were done on 64-slice MDCT. Opacification of digestive tract wasachieved by oral administration of diluted 40 ml of ionic contrast in 2 liters of water. Thepatient was asked to take 1.8 liters of this diluted contrast at regular intervals for three hours. The patient was asked to lie supine on CT table with arms positionedcomfortably above the head in the head-arm rest and lower legs supported. Patient was nowasked to take the remaining 200 ml. of diluted contrast to opacify the stomach. Patient wasasked to hold their breath and a topogram was taken.• The patient was subjected to a spiral CT scan and non-contrast 5mm contiguous axialsections were taken from the level of domes of the diaphragm up to the level of third lumbarvertebra. These spiral images were evaluated and further triple-phase study was planned.• On non-contrast images, the pre-monitoring slice was decided and a marker for monitoringwill be placed on the aorta. The dose of intravenous contrast medium to be given wascalculated according to the weight of the patient. For an average adult patient nonioniccontrast 100 ml, of an ionic concentration of 300 mg I/ml was injected intravenously.• After securing the intravenous cannula in the forearm it was flushed with the intravenoussaline to ensure the patency of the vein, the intravenous line was connected through theextension cannula to the automatic pump injector. The settings were adjusted and contrastwas injected automatically at the rate of 3.5-4 ml/ second with 325 psi. The injector andmeasurement buttons were pressed simultaneously.• The equipment continued to take a monitoring slice and the moment contrast reachesa HU value of 100 in the aorta, the radiation exposure

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started automatically and the arterial 5.phase spiral images were obtained.• After a delay of about 22 seconds, the portal venous phase spiral images were obtained.• After these two phases the third scan will be taken in the hepatic venous/equilibrium phase70- 80 sec after injection of contrast.• If the lesion appears to be a hemangioma/cholangiocarcinoma/scar assessment, then adelayed phase scan is taken at 8-10 min.• Vital parameters and general condition of the patient were checked for any post-contrastcomplications.• The radiological findings in axial, sagittal, and coronal sections, MIP and MinIP were used toestablish the radiological diagnosis of the disease. The contribution of these viewingoptions to the diagnosis and their impact if any to the diagnosis of the diseases were studied.Variations were made depending on the patient's condition.• During CT evaluation, the following features were noted, viz., location, number of masslesions, margins, NCCT feature, arterial phase, Porto-venous phase and delayed phasechanges (washout characteristics), lymph node involvement and ascitic features. Otherspecific features helpful in diagnosis were made wherever needed.

Result And Observations

The present study was planned to characterize various hepatic lesions with the help of a triple-phase multidetector CT scan. Subsequently, correlation of these characteristics was done with histopathological/ cytopathological findings and final diagnosis.For this purpose, a total of 40 hepatic lesions falling in the sampling frame as described in Materialsand Method were enrolled in the study.The age of patients ranged from 3 years to 85 years. Maximum number of patients were aged 61-70 years (35%) followed by those aged 51-60 years (25%) and >70 years (17.5%) respectively.There were 6 (15%) cases in the age group ≤ 40 years and 3 (7.5%) cases in the age group 41-50 years.In the present study, majority of patients were males (65.00%). There were 14 (35.00%)females. The male-to-female ratio of patients was 1.85.The majority of patients (60.00%) had right lobe involvement, bilobar involvement was noted in10(25%) patients and least was left lobe involvement in6 (15%) patients. Majority had single24 (60.00%) lesions, with well-defined margins 31(77.5%). There were 16 (40.00%) havingmultiple lesions, 9 (22.5%) had ill-defined margins. On NCCT majority of lesions 38 (95%)appears hypodense.On the basis of triphasic CT assessment, a total of 21 out of 40 (52.5%) patients were diagnosedas malignant and the remaining 19 (47.5%) were diagnosed as benign. Among benign lesions –11(27.5%) were diagnosed as hemangiomas, 4(10%) were hepatic abscesses and 2(5%) weresimple cysts. Hepatic adenoma and F.N.H contributed 1(2.5%) each. Among malignantmasses, metastasis was most commonly seen in 12(30%) cases. Hepatocellular carcinoma wasdiagnosed in 7(17.5%) cases. Among the metastasis, carcinoma gall bladder metastasis wasseen in 2 cases, followed by carcinoma lung metastasis (n=3), unknown primary (n=4; 10.9%),

6.carcinoma

breast metastasis (n=1), carcinoma colon metastasis (n=1;). There was one case ofmetastasis from R.C.C.In the arterial phase, except for 10 (25.0%) cases enhancement was seen in all cases. It washomogenous in 8 (20.0%) cases, heterogeneous in 5 (12.5%), peripheral enhancement in 6(15.0%) case and peripheral nodular enhancement in 11 (27.5%) cases.In the Portal venous phase, heterogenous enhancement was seen in 11 (27.5%) cases, 6 (15.0%)cases showed washout. There were 11(27.5%) cases showing centripetal filling in, 3 (7.5%)isodense lesions and 9 (22.5%) non-enhancing/hypodense lesions.In hepatic venous phase, heterogenous enhancement was seen in 5(12.5%) cases, 6 cases (15%)showed washout and centripetal filling in in 11(27.5%) cases. Non-enhancement was noted in 1 case.In delayed phases, 1 (4.7%) case showed scar enhancement, 2 (9.5%) cases showedheterogenous enhancement and homogenous enhancement was noted in 11 (52.3%) cases.On cytohistopathology of 29 cases, a total of 14 were diagnosed as adenocarcinoma followedby 7 hepatocellular carcinomas. There was one case each diagnosed as F.N.H and Hepaticadenoma respectively. There were 4 cases diagnosed as Abscesses and 2 diagnosed as benignsimple cysts. One case on histopathology was diagnosed as a benign regenerative nodule.Based on the final diagnosis, a total of 20 (50.0%) were identified as malignant – amongthese, hepatocellular carcinomas were 6 (15%.0). Other malignant masses included metastasisadenocarcinoma gall bladder (n=2; 5.0%), metastasis lung adenocarcinoma (n=3;

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7.5%),metastasis adenocarcinoma unknown primary/hepatic infiltration (n=4;10%), metastasis breastcancer (n=1; 2.5%), metastasis adenocarcinoma colon (n=1; 2.5%) respectively and metastasisadenocarcinoma RCC (n=1; 2.5%). In the last malignant category n=2 (5.0%) cases were ofcholangiocarcinoma.There were 20 (50.0%%) benign cases, 11 (27.5%) cases of hemangioma and 4 (10%) cases ofhepatic liver abscesses. There were 1 (2.5%) case each of hepatic adenoma, F.N.H andregenerative nodule and 2 (5%) cases of simple cysts.

Discussion:

Lesions of the liver may arise from hepatocytes, biliary epithelium, mesenchymal tissue ormetastases from extrahepatic tumors. The size of the liver lesion is extremely important inguiding the evaluation. Lesions <1.0 cm are commonly benign incidental findings, representing7cysts, hemangiomas or biliary hamartomas. While malignancy is often the concern with livermasses, most often the so-called 'incidentalomas' are benign and require patient reassurance.Liver lesions can be broadly divided into the following types: benign lesions, malignant lesions,cysts and abscesses.They can also be classified on the basis of origin and type as:(i) Hepatocellular origin – that includes adenoma, regenerating nodules, nodularregenerative hyperplasia and focal nodular hyperplasia as the benign and hepatocellularcarcinoma, fibrolamellar carcinoma and hepatoblastoma as the malignant forms.(ii) Cholangiocellular – that includes bile duct adenoma and biliary cystadenoma as thebenign; and cholangiocarcinoma and cystadenocarcinoma as the malignant forms.
7.(iii) Mesenchymal – that includes hemangioma and angiolipoma as the benign andangiosarcoma and primary lymphoma as the malignant forms.(iv) Heterotopic – that includes adrenal/pancreatic benign and metastatic types as themalignant forms.Keeping in view the scope of the present study, the review of literature is limited to benign andmalignant lesions only. The brief overview of different common malignant lesions is asfollows:(i) Hepatocellular carcinoma (HCC): HCC is the third most common tumor worldwideand the second leading cause of cancer-related deaths. The incidence of HCC has beenrising, with chronic hepatitis C virus infection as the main driving force behind thisincrease [17].The classic clinical features of HCC include right upper quadrant pain and weight loss,worsening liver function in a patient known to have cirrhosis, acute abdominalcatastrophe from rupture of a liver tumor with intra-abdominal bleeding, and some rareextrahepatic manifestations.Imaging plays a key role in the diagnosis of HCC. There has been a steady evolution inthe radiologic techniques used to diagnose HCC.Ultrasound examination continues to play a role in detecting HCC and can detectvery small lesions within the liver. More recent practice has focused on the use of spiralCT and magnetic resonance imaging with multiphase contrast enhancement [18].8HCC derives its blood supply predominantly from the hepatic artery whereas theremainder of the liver receives both arterial and portal blood. HCCs therefore enhanceearly during the infusion of contrast, in the arterial phase (the first 20-40 seconds afterintravenous infusion of contrast). The liver parenchyma enhances during the portalvenous phase, which takes place 50-90 seconds after infusing contrast. Miller et al. have suggested that many HCC tumor nodules found on examination of explanted livers are not detected by CT examination before transplantation [19].The use of dynamic MDCT helps in the identification of poorly differentiated HCC patients toowhich is marked by hypervascular enhancement patterns whereas hypovascular-typeenhancement is common in well-differentiated HCC. Thus, imaging patterns of dynamicMDCT scanning in HCC patients may be helpful for follow-up examinations and fordetermining clinical prognosis [20].(ii) Fibrolamellar carcinomas (FLC): FLC is a unique type of primary liver cancer. Theyoccur most commonly in children and young adults. FLCs are not indolent tumors, buthave an overall better prognosis than typical HCC, in part because of the younger age atpresentation and the lack of cirrhosis [21]. FLC generally present with vague, nonspecificclinical signs and symptoms [22]. These are seen to be similar in all ages, i.e. even inadolescents and young adults [23].FLC characteristically appears on radiological images as a lobulated heterogeneous masswith a central scar in an otherwise normal liver. Imaging features of FLC overlap withthose of other scar-producing lesions including FNH, hepatocellular adenoma andcarcinoma, hemangioma, metastases, and cholangiocarcinoma. FNH, in particular, maysimulate

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FLC, since both have similar demographic and clinical characteristics. However,occasionally FLC may be initially detected as an enlarged liver, liver mass or hepatic 8.calcification. Calcifications, usually nodular or stellate and small in relation to the tumorhave been visualized in upto 40% of abdominal radiographs [24].(iii) Hepatoblastoma (HB): Hepatoblastoma (HB) is the most common pediatric livermalignancy, comprising approximately 1% of all pediatric cancers [25]. It affects mostlyinfants and young children between the ages of 6 months and 3 years, although neonatesand adolescents with HB also have been reported.HB presents on abdominal ultrasound as a well-defined, hyperechoic, solid, usually non-cystic intrahepatic mass, frequently (60–70%) located in the right lobe of the liver [26].Characteristically, CT scan reveals a delineated mass with low attenuation compared withthe surrounding normal liver parenchyma [27].(iv) Cholangiocarcinoma (CCA): CCA can be divided further into intrahepatic CCA(ICCA) or extrahepatic CCA (ECCA). MRI and CT have a great assistance in the diagnosisof CCA. ICCA takes up contrast agents progressively during the arterial and venous phasesof studies — especially if the lesion is > 2 cm, because of its extensive desmoplasticreaction. Other associated findings may include hepatic capsular retraction, vascularencasement that may lead to lobar atrophy, and dilatation of peripheral bile ducts. ICCAmay be difficult to differentiate from a metastatic lesion (especially a metastasis from aforegut adenocarcinoma) by imaging and histology [28].(v) Liver Metastases: Although the liver is the most common site of metastatic disease froma variety of tumor types, isolated hepatic metastases most commonly occur fromcolorectal cancer and, less frequently, from NET (neuroendocrine tumors), GI sarcoma,ocular melanoma, and others.As many as 50% of the patients with a primary malignancy will eventually developmetastases in the liver. For most other solid malignancies, the pattern of metastaticdisease is most often that of generalized dissemination [29].For evaluating metastasis CT is the imaging modality of choice. The reason behind CTbeing the modality of choice is largely attributable to the effects of the dual blood supplyon the enhancement characteristics of metastases, when compared with normal liverparenchyma. For detection and characterization of small lesions and to evaluate the liver10with background fatty liver changes, MRI may be superior to MDCT and positronemission tomography (PET) [30].The benign lesions of liver might be studied as follows:(i) Adenoma – They are benign epithelial liver tumors, seen most commonly in women ofchildbearing age. They usually develop in an otherwise normal liver and are typicallylocated in the right hepatic lobe. The number of reported cases of hepatic adenomas hasincreased dramatically since the 1960s, coinciding with the introduction of oralcontraceptives [31]. The annual incidence of hepatic adenomas is approximately 1 permillion in women who have never used oral contraceptives, compared to 30–40 permillion in long-term users [32].Hepatocellular adenoma is usually a well-defined, well-circumscribed, non-lobulatedlesion, and resected hepatocellular adenoma at gross examination frequently demonstratesareas of haemorrhage and infarction. Color Doppler USG may help differentiatehepatocellular adenoma from focal nodular hyperplasia. Multiphasic Multidetectorhelical CT has a high accuracy for the detection and characterization of focal hepatic lesions. 9.Understanding the imaging appearance of hepatocellular adenoma can help avoidmisdiagnosis and facilitate prompt, effective treatment [33].(ii) Nodular Regenerative Hyperplasia (NRH) / Focal Nodular hyperplasia (FNH)-FNHis the second most common benign solid tumor of the liver, with an estimated prevalenceof 2.5–8% (35). FNH is found in both genders and across all ages; however, it is notedmore frequently in women (female-to-male ratio, 8:1) with a peak incidence between thethird and fifth decades of life [34)].FNH is thought to represent a hyperplastic response of hepatic parenchyma tohyperperfusion by vascular malformations in the liver, a theory that is strengthened bythe association of FNH with other vascular anomalies such as hereditary hemorrhagictelangiectasia [35]. Focal nodular hyperplasia is most often solitary (80% of cases) andmost lesions are 3–5 cm in size [36]. Radiological features are quite characteristic in FNH with the dominant feature being the presence of a central scar. Triphasic CT scan reveals a hypo or isodense lesion that 11 homogeneously enhances during the arterial phase of contrast injection given the arterial blood supply of FNH and then returns to

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its precontrast density during the portal venous phase [37]Heiken JP et al, 1989, conducted a study comparing the sensitivity of MRI, CTAP (CT duringarterial portography), non-contrast, delayed CT for detecting focal liver lesions. The studyconcluded the fact that CTAP is the most accurate technique to be available to the radiologist.Leewen et al.in 1996, assessed whether triphasic spiral CT enables the characterization of a wide range of focal liver lesions. Out of 11 enhancement patterns, six were always due to benign disease and caused by areas with hyper- or hypoperfusion, simple cysts, F.N.H(focal nodular hyperplasias), hemangiomas, or benign but nonspecified lesions. Malignant disease shows two out of 11 enhancement patterns, and one pattern was due to malignant disease in 97% of 39 patients with known malignancy elsewhere or with chronic liver disease [38]. Metastases and partly fibrosed hemangiomas showed two other patterns of enhancement. The authors concluded that triphasic liver CT enables characterization of a wide range of focal liver lesions, including the benign liver lesions that occur most frequently [39].Ruppert-Kohlmayr et al. in 2001 performed a study for evaluating differences of attenuationand enhancement patterns in focal nodular hyperplasia and hepatocellular adenoma and furtherquantified using triphasic single slice helical CT. Combination of triphasic helical CT with quantitative evaluation of liverlesions offers the possibility of detecting differences in liver lesions that are visually similar onCT. The attenuation and relative enhancement in the arterial phase show significant differencesthat make accurate differentiation between focal nodular hyperplasia and hepatocellularadenoma possible [40].Kopp et al. in 2001 reported that MDCT has improved hepatic imaging owing to improvedz-axis coverage speed and longitudinal resolution. Rapid hepatic imaging and allowing newimaging protocols were the mainstay of improvement in the study. In single-breath-hold, thin sections can be used on a routine basis. The result is an improvement in lesion detection andthe nearly isotropic image acquisition providing high-resolution multiplanar reformations.With the improvements in morphological and functional information in multidetector-row CT compared with single-slice CT has enabled a comprehensive approach to liver imaging and lesion detection within a single examination [41].Lee et al. in 2008, compared the diagnostic performance of multidetector row helical CT andgadobenate dimeglumine-enhanced magnetic resonance imaging in the detection andcharacterization of focal liver lesions [42].Ma X et al. in 2008 estimated the optimal time delay before the initiation of the arterial phasescanning for detection of hypervascular HCC on 16- MDCT when a rapid bolus injection ofcontrast medium is administered and found that when 70 ml of 300 mg I/mL of contrastmedium with an injection rate of 7 mL/s in 16-MDCT scanning. The optimal time to initiatescanning for HCC is 26.3 +/- 2.9 seconds (range, 24.0-34.5 seconds) after contrast mediumadministration [43].Nakaura et al. in 2008 conducted a study evaluating the performance of radiologists indetecting focal enhancement during the HAP with a single breath-hold dynamic subtractionMDCT of the liver and concluded that there was significant improvement in the diagnosticperformance of radiologists in the detection of focal enhancement during the HAP with thedisplay of subtracted images ($p<0.01$) [44].Lee et al. in 2008, evaluated the three-phase helical CT features of early HCC, based on thenew Japanese classification and found that all the tumors had an ill-defined margin with nofibrous capsule. Only one tumor showed the mosaic pattern. Only three (43%) of seven tumors16detected on CT were hyperattenuating during the arterial phase. The four remaining tumors(25%) were hypoattenuating during the three phases [45].Hafeez et al. in 2011, correlated the triphasic CT diagnosis of focal liver lesions in 45 patientswith 136 liver lesions (11 benign and 125 malignant) were detected with the help of differentenhancement patterns. Malignant lesions were noted in 37 (82.2%) patients and benign in 8(17.8%) patients out of them. All the hepatocellular carcinoma showed enhancement in the arterial phase, out of which 54 were detected in the arterial phase only. Porto-venous phase showed lesions better in 9 cases and hypoattenuation in 11 lesions. In 11 patients, 30 hypervascular and 21 hypovascular metastatic[46].Furlan et al. in 2011, compared retrospectively HVP and delayed phase (DP) images for thedetection of tumor washout during multiphase MDCT of the liver in patients with HCC. They concluded that the DP is superior to the HVP for the detectionof tumor washout of pathologically proven

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HCC in cirrhotic patients [47].Chung et al. in 2013 compared the accuracy of contrast-enhanced multidetector CT andgadolinium ethoxy benzyl diethylenetriamine Penta acetic acid (Gd-EOB-DTPA) enhancedMRI for characterization of incidental liver masses. They included 127 incidentally found focalliver lesions (94 benign and 33 malignant) from 80 patients (M: F=45:35) without primaryextrahepatic malignancy or chronic liver disease. Then the study compared the diagnosis between EOB-MRI andMDCT for the remaining disease. The results suggested that Gd-EOB-MRI may provide ahigher proportion of confident interpretations than MDCT, especially for the diagnosis ofincidentally found FNH and focal eosinophilic infiltration [48].Chauhan et al. in 2015, evaluated the features of various hepatic masses using triple phasemultidetector computed tomography in a total of 45 patients. Out of 45 cases, there were a totalof 4 benign and 41 malignant masses. Of the 4 benign cases, there were 3 hemangiomas and 1infantile hemangioendothelioma. Of the malignant masses, 16 cases were of metastases, 14cases were carcinoma gall bladder with hepatic infiltration, 5 cases were of HCC and 3 eachwere hepatoblastoma and cholangiocarcinoma. All the hemangioma cases were hypodense on plain scan and showed early discontinuous peripheral enhancement in the arterial phase withprogressive centripetal filling in the delayed phase. All the HCC cases were hypodense on non-contrast CT (NCCT) and showed early enhancement in the arterial phase with persistentenhancement in the Porto-venous inflow phase and washout in the Porto-venous phase. Out of 3 cases of hepatoblastoma two lesions were hypodense on NCCT (33%) while one was heterogeneous.Calcification was noted in only one lesion. Arterial phase enhancement was shown by one ofthe lesions with evidence of washout in the Porto-venous phase (early washout). Porto venousinflow and Porto venous phase enhancement were shown by two lesions with no evidence ofearly washout rather they showed persistent enhancement. All three cholangiocarcinomacases were isodense on NCCT and showed no enhancement in arterial and Porto venousinflow/late arterial phase but were enhanced in the delayed phase (100%). Out of 16 metastasescases, 7 cases (43.75%) showed enhancement in the arterial phase while 3 cases each (18.75%)showed enhancement in Porto venous inflow and Porto venous phase. Three (18.75%) casesremained un-enhanced in all the phases. Two cases showed washout (12.5%) while 7 cases(43.75%) showed persistent enhancement. Among 14 cases with carcinoma gall bladder withhepatic infiltration, most of the lesions showed early enhancement in the arterial phase (57.14%).Non-enhancement in all the phases was shown in one case. Only one case showed earlywashout while 12 cases showed persistent enhancement (87.71%). The triphasic CT showed97.78% correlation with final diagnosis. The authors found the modality to be highly accuratefor the detection and characterization of hepatic masses in addition to be able to provide significant information for the planning and management of the disease [49].Goel et al. in 2016 reported the findings of 38 cases with suspected liver masses evaluatedusing triphasic CT and confirmed the diagnosis histopathologically. A total of 26 cases wereconfirmed as malignant and 12 as benign. Triphasic CT correctly diagnosed 96.2% of themalignant lesions and 100% of the benign lesions. Out of 12 benign cases – 9 were20 hemangioma, 1 hepatocellular adenoma, 1 focal nodular hyperplasia and 1 liver abscess. Thehemangioma cases were characterized by hypodense pattern on NCCT, peripheral nodularenhancement in the arterial phase, centripetal fill or peripheral enhancement in the portal venous phase and an isodense pattern in the delayed phase. Among 26 malignant cases – 8 were HCC, 2cholangiocarcinoma and 16 metastasis. In HCC cases, hypodense/isodense pattern on NCCT,heterogeneous enhancement in the arterial phase, hypodense pattern in the portal venous phase and hypodense pattern in delayed phase were characteristics of triphasic CT findings. In metastasis cases, hypodense pattern on NCCT, enhancement in the arterial phase, hypodensity or peripheral enhancement in the portal venous phase and hypo/isodensity in the delayed phase were the characteristic findings [50].S jain et al. in 2019 This study opens new possibilities for the prevention of liverdisease with early detection and consequent management of hepatic lesions [51].Diagnosis of liver lesions is a difficult task owing to their heterogeneous nature and varying possible etiologies. The texture and nature of the tissue involved also

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make it difficult for imaging techniques to help in diagnosis. In the past two decades, triphasic computed tomography has come up as a useful diagnostic imaging modality for the identification of different types of hepatic lesions. Owing to its sequential imaging nature in arterial, portal, venous and delayed phases, it provides a dynamic perspective of the liver lesions which otherwise are quite difficult to diagnose. In the present study, we attempted to characterize 40 such hepatic lesions and ended up characterizing 20 (50%) of them as malignant and 20 (50%) as benign. The reasons for the high malignancy rate in our series as well as in some of the other series from this region could be multiple – including poor diagnostic infrastructure, lack of adequate healthcare facilities, dietary habits, alcohol consumption, and treatment of early symptoms as simple gastrointestinal manifestations in the absence of a good primary healthcare structure. It must be kept in mind that most of benign liver lesions have a high malignancy potential(8). In the absence of adequate diagnostic facilities and detection at a delayed stage, the overall malignant and benign rates in our settings are similar because we included all the cases having focal lesions in the liver i.e. asymptomatic or symptomatic, incidental or true benign cases on other modalities. In the present study, we did not exclude the cases with USG features suggestive of abscesses and cysts, thus offering equal chances of malignant and benign detection. In the present study, majority of patients were males (65.0%). Male to female ratio was 1.85. The male-to-female ratio for liver cancer is highly skewed in India. For HCC reportedly stands at 4:1 (6). For different benign lesions, a high male dominance has been reported as reported by Hartley et al.Although for lesions like FNH a high dominance of females has been reported [34]. However, one of our patients was finally diagnosed with FNH. However, the evidence from the Indian subcontinent does not show a set gender predisposition. In the study by Hafeez et al. more than two-thirds (68.3%) cases were males [46]. However, Goel et al. reported a female predominance with 60.5% of their cases as female [50]. Chauhan et al. also reported female dominance with 55.56% of female cases [49]. The benefits of CT are easy to access due to wide availability and patient-friendly protocols allowing even a chest–abdomen–pelvis CT examination in a less than 20-second breath hold using multidetector CT technology as observed by Hopper et al. The MDCT evaluation showed right lobar involvement in the majority (60.0%) along with single lesion (60.0%) with well-defined margins (77.5%) and hypodense appearance on NCCT 49(92.5%). In the arterial phase, except for 10 (25.0%) cases enhancement was seen in all cases. It was homogenous in 8 (20.0%) cases, heterogeneous in 5 (12.5%), heterogeneously peripheral enhancement in 6 (15.0%) cases and peripheral nodular enhancement in 11 (27.5%) cases. In the Portal phase, heterogenous enhancement was seen in 11 (27.5%) cases, 6 (15.0%) cases showed washout. There were 11(27.5%) cases showing centripetal filling in, 3 (7.5%) isodense lesions and 9 (22.5%) non-enhancing/hypodense lesions. In the hepatic venous phase, heterogenous enhancement was seen in 5(12.5%) cases, 6 cases (15%) showed washout and centripetal filling in in 11(27.5%) cases. Non-enhancement was noted in 1 case. In delayed phases, 1 (4.7%) case showed scar enhancement, 2 (9.5%) cases showed heterogenous enhancement and homogenous enhancement was noted in 11 (52.3%) cases. This implies that there was much useful information available with MDCT and triphasic assessment. In the present study in order to character hepatocellular carcinoma we used the criteria hypodense on non-contrast, intensely enhancing in the arterial phase, portal-venous rapid washout and no enhancement in the delayed phase. Thus, there was a washout in all the cases in the portal-venous phase. There is controversy regarding Porto-venous versus delayed phase washout for the detection of hepatocellular carcinoma. In one such study, delayed phase washout was considered to be superior to delayed Porto-venous washout for characterization of HCC [47]. In the present study, we had a complete washout of all the masses that were intensely enhanced in the arterial phase, thus indicating a high possibility of hepatocellular carcinoma. In the present study, additional findings as well as peripheral enhancement of lesions in arterial and portal-venous phases helped to identify the metastatic cases more effectively. Tumor washout, i.e. hypoattenuation relative to the adjacent hepatic parenchyma during the hepatic venous or delayed phase, has been recognized as a strong predictor of HCC. This washout characteristic helps to improve the diagnosis

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of hepatocellular carcinoma which is an intensely-enhanced mass in the arterial phase. Hepatocellular carcinoma, owing to its localization has high vascularity and that is why it is intensely enhancing in the arterial phase. However, sometimes owing to cirrhosis it is hypovascular and hence hypodense but completely washes out in portal-venous or delayed phase. As far as metastasis is concerned, it is generally hypovascular in nature and is best detected during the Porto-venous phase [46]. Owing to their limited access to the liver, they are peripherally or regionally limited and show enhancement at particularly affected sites. In the present study, we had a high proportion of peripheral enhancement in the portal-venous phase that was reflective of a metastatic invasion of the liver. In the present study, a significant proportion of centripetally 50enhancing lesions in the delayed phase were an indication of a benign lesion. Benign lesions are generally less vascular and hence are often not enhanced in arterial and portal-venous phase when enhancement of more vascular masses is prominent, instead in delayed phase they can be marked out owing to their less vascular characteristic and smaller size. Similar to our study, Goel et al. also found that benign lesions are either hypodense or isodense on NCCT and generally are non-enhancing in the arterial phase. In their study, they found intense enhancement in the arterial phase for focal nodular hyperplasia only. However, in the present study, there was one case of FNH that showed heterogenous intense enhancement on the arterial phase. The characteristic centripetal filling of benign lesions was visible in 11 out of total 20 benign lesions in the delayed phase reemphasized their benign nature. In the present study, the majority of cases (n=14; 35%) were adenocarcinoma, mainly suggestive of the metastatic nature of the affected liver masses. There were 6(15%) hepatocellular carcinoma. There were 20 benign cases – hemangioma (n=11), abscess(n=4), simple cyst(n=2), adenoma(n=1), F.N.H(n=1), regenerative nodule(n=1). In the present study, benign and malignant cases were in equal proportions. The present study had a significant number of metastatic lesions. The proportion of metastatic masses among suspected liver masses has shown much variability. One of the reasons for the high number of metastatic lesions in the present study could be the high prevalence of carcinoma gall bladder in this belt. Interestingly, carcinoma gall bladder was the most common site responsible for metastasis to liver. In the present study, the overall efficacy of triphasic MDCT in terms of sensitivity, specificity, positive predictive value and negative predictive value was 100%, 88.8%, 95.2% and 100% respectively. The method had an accuracy of 94.0%. Similar to the present study, high diagnostic efficacy of triphasic MDCT was reported by Hafeez et al. who reported it to be 100% sensitive and 80% specific . In their study, the positive predictive value was 94.6% and the negative predictive value was 100%. They found triphasic MDCT to be 95.6% accurate. These efficiency values were similar to ours. The superiority of MDCT in the detection of malignancy could be attributable to the ability of different phases based on the vascular nature of masses. However, owing to the average number of benign cases, only 1 misdiagnosis in the present study and 2 misdiagnoses in the study by Hafeez et al. led to loss of specificity by 11.2%. In another study, that had only 4 benign cases as compared to 31 malignant cases, the sensitivity of MDCT was reported to be 90.3%, however, owing to 2 misdiagnoses, the specificity was dropped down to 50%. In the present study, we found age to be significantly associated with hepatocellular carcinoma and metastasis, thus justifying the high prevalence of malignant cases as discussed earlier. Male sex was also significantly associated with hepatocellular carcinoma. The higher predisposition of male sex to HCC could be attributable to alcoholic liver disease as the etiology. In our region, alcohol consumption among males is quite prevalent and its possible transformation to HCC cannot be ruled out to be the reason for the high prevalence of HCC in males. The higher prevalence of HCC in males is a reported epidemiological fact too [6]. In the present study, weight loss and anorexia were the other differentiating factors between different types of masses with both these characteristics being present in a significantly higher proportion of metastatic cases as compared to HCC or benign cases. The reason for this could be probably impact of both primary as well as metastatic progression of malignancy, which eventually had an impact on the general well-being of the patient. In characterizing MDCT characteristics for different pathologies of liver masses, we found bilaterality, multiplicity and NCCT echotexture characteristics to

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be differentiating factors among different pathologies. Among different CT characteristics prior to triphasic assessment, the presence of hypodense echotexture on NCCT was not much of a help in characterizing it as most of the lesions appeared hypodense however multiplicity was more common in metastatic types. On triphasic CT, intense or heterogeneous enhancement in the arterial phase followed by washout in the PV phase was the characteristic finding of HCC. Metastatic lesions either had no enhancement or less frequent intense enhancement in the arterial phase, peripheral enhancement in the PV phase and absence of enhancement in the delayed phase as the characteristic findings whereas benign lesions were characterized by centripetal enhancement in the delayed phase. All these findings have been discussed at length in detail for their differentiating attributes in the earlier part of this discussion and correspond with the findings in other studies too. The findings of the present study showed that triphasic MDCT is a useful modality for the diagnosis and characterization of liver masses, it is superior to USG as it provides plentiful information from extra-abdomen primaries and hence is useful in situations where the liver lesions are not caused by a primary lesion and are metastatic. These findings are interesting. However, fewer benign cases are a big barrier that needs to be surpassed for exact evaluation of the usefulness of this modality. As a matter of fact, being more sensitive as well as specific, its use following a USG assessment seems to be a viable choice. Further studies in this direction is recommended.

Conclusion

The present study was planned to characterize various hepatic lesions with the help of triplephase multidetector CT scan. Subsequently, correlation of these characteristics was done withhistopathological/cytopathological findings and final diagnosis. For this purpose, a total of 40patients with hepatic lesions were assessed and analyzed using triple phase multidetectorcomputed tomography followed by histo/cytopathological evaluation for confirmation.On the basis of triphasic MDCT evaluation, malignant etiology was established in 20/40(50.0%) of cases – including 6 (15%) cases diagnosed as hepatocellular carcinoma, 14(35%)cases diagnosed as metastatic lesions. Benign etiology was established in 20/40 (50%) patients– including 11(27.5%) cases diagnosed as hemangioma, 4(10%) cases of abscesses, 2(5%) ofsimple cysts and 1(2.5%) each of adenoma, F.N.H and hepatic regenerative nodule.On correlating the triple phase MDCT findings with clinical profile of patients, Older age, andmale gender were significantly associated with triphasic MDCT diagnosed HCC and metastasis.Compared to histopathological/cytopathological findings, triphasic CT had the sensitivity,specificity, positive and negative predictive values of were 100%, 88.8%, 95.2% and 100%respectively for diagnosis of malignancy. The method had an accuracy of 94.0%. Except for1 histopathological proven case of benign liver disease which was wrongly interpreted as HCCby triphasic CT, all the others were diagnosed perfectly. The level of agreement was excellent(κ=0.950; p<0.001)On triphasic CT, in arterial phase, intense or heterogeneous enhancement followed by washoutin PV phase were the characteristic findings of HCC. Metastatic lesions either had noenhancement or less frequent intense enhancement in arterial phase, peripheral enhancementin PV phase and absence of enhancement in delayed phase as the characteristic findingswhereas in benign lesions hemangiomas were characterized by centripetal filling in insuccessive phases, peripheral wall enhancement in arterial phase in hepatic abscess, noenhancement in simple cysts and heterogenous intense enhancement in arterial phase in F.N.Hand adenoma.The results of this study prove MDCT to be highly sensitive in sorting the hepatic lesions intoclinically relevant categories which helps in achieving correct diagnosis and evaluation oflesion. This study opens new possibilities of prevention of liver disease with early detectionand consequent management of hepatic lesions. On the basis of these conclusions we canrecommend the use of triphasic CT in suspicious hepatic masses.

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Tables And Figures:

Table 1: Demographic Profile of cases enrolled in the study (N=40)

S.No.	Characteristic	No. of cases	Percentage
1.	**Age (In Years)**		
	<40	6	15.00%
	41-50	3	7.50%
	51-60	10	25.00%
	61-70	14	35.00%
	>70	7	17.50%
2.	**Gender**		
	Male	26	65.00%
	Female	14	35.00%

Table 2: CT Findings of Hepatic Lesions

SN	Finding	No. of cases	Percentage
1.	Location		
	Bilobar	10	25
	Left Lobe	6	15
	Right Lobe	24	60
2.	Number		
	Single	24	60
	Multiple	16	40
3.	Margins		
	Ill defined	9	22.5
	Well defined	31	77.5
4.	NCCT Feature		

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	Hypo	38	95.00
	Iso	1	2.5
	Iso + Hypo	1	2.5

Table 3: Triphasic CT Findings of Hepatic Lesions

S.No.	Finding	No. of cases	Percentage
1.	Arterial Phase		
	Homogeneously enhancing	8	20
	Heterogeneously enhancing	5	12.5
	Peripherally nodular enhancing	11	27.5
	Peripherally enhancing	6	15.0
	Non-enhancing / Hypodense	10	25
2.	Porto venous Phase		
	Centripetal fill in	11	27.5
	Heterogeneously enhancing	11	27.5
	Washout	6	15.0
	Isodense	3	7.5
	Non-enhancing / Hypodense	9	22.5
3.	Hepatic Venous Phase		
	Centripetal fill in	11	27.5
	Heterogeneously Enhancing	5	12.5
	Hypodense	14	35.0
	Peripherally enhancing	1	2.5
	Non-enhancing	1	2.5
	Washout	6	15.0
	Isodense	2	5.0
4.	Delayed phase		
	Scar enhancement	1	4.7
	Heterogeneously Enhancing	2	9.5
	Homogeneously enhancing	11	52.3
	Washout	5	23.8

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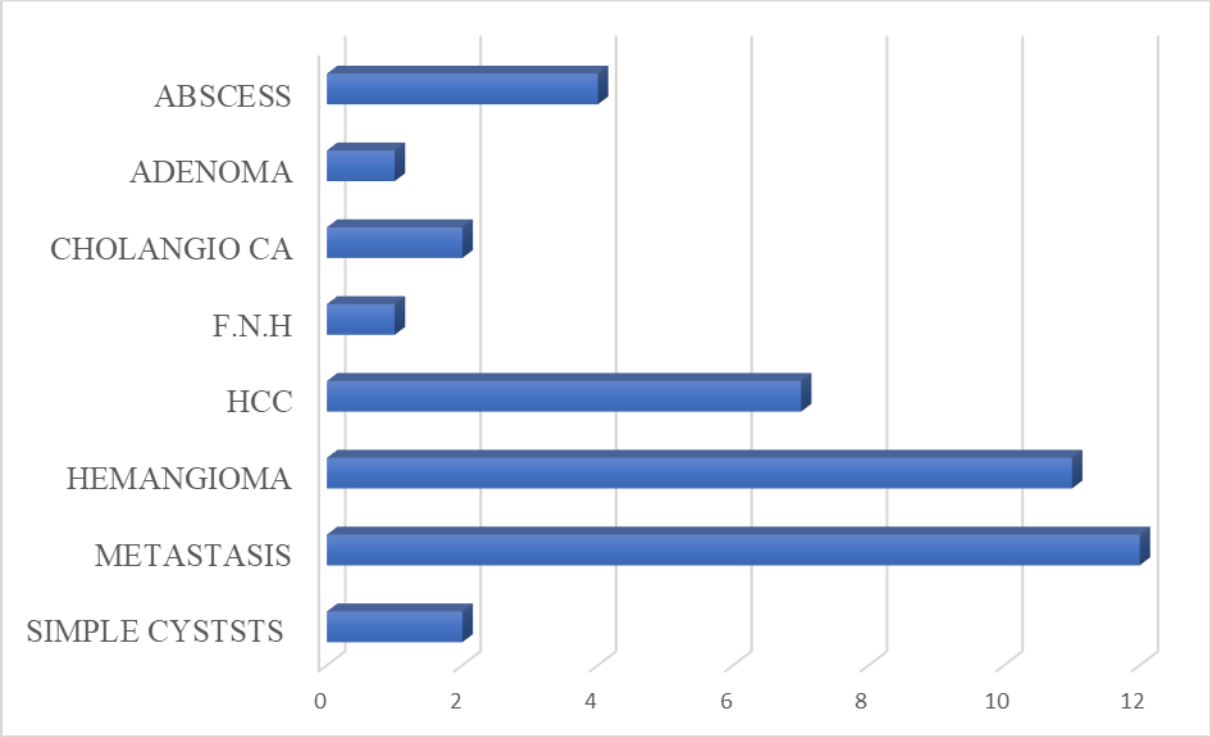
	Hyopdense	2	9.5

Fig. 1: Triphasic CT Diagnosis of Liver Lesions



Significantly higher proportion of metastasis cases (66.67) had bilobar involvement ascompared to benign masses (10%) (p=0.003). Number of multiple lesions was significantlyhigher in metastatic masses (75%) and HCC (50.0%) as compared to Benign masses (20%)(p=0.012). On NCCT, all the HCC, metastasis and cholangiocarcinoma cases were hypodenseand 10% of benign lesions were isodense.In Arterial phase, proportion of those with homogeneous enhancement was higher in HCC(100%) as compared to metastatic (0%) and benign (10%). Proportion of peripheral nodularenhancement was highest in benign category (55%). This difference was significantstatistically (p=0.0001)

In Portal venous phase, proportion of those showing washout was higher in HCC (100%) andheterogenous enhancement was highest in metastatic category (91.67%). Centripetal filling inwas maximum in benign (55%). Statistically, these differences were significant (p=0.0001).In hepatic venous phase, proportion of those appearing hypodense was higher in HCC (100)and benign (35%). Washout was highest in metastasis (50%) and this appeared to bestatistically significant (p<0.0001)In delayed phase, benign lesions showed homogenous enhancement in 84.62% as compared tonone in HCC and metastasis groups. Statistically, this difference was significant (p<0.0001).

Table 4: Diagnostic Efficacy of Triphasic MDCT for Detection of Malignant Liver Masses

S.No.	Triphasic MDCT Diagnosis	Final Diagnosis		Total
		Malignant	Benign	
1.	Malignant	20	1	21
2.	Benign	0	19	19

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Total	20	20	40

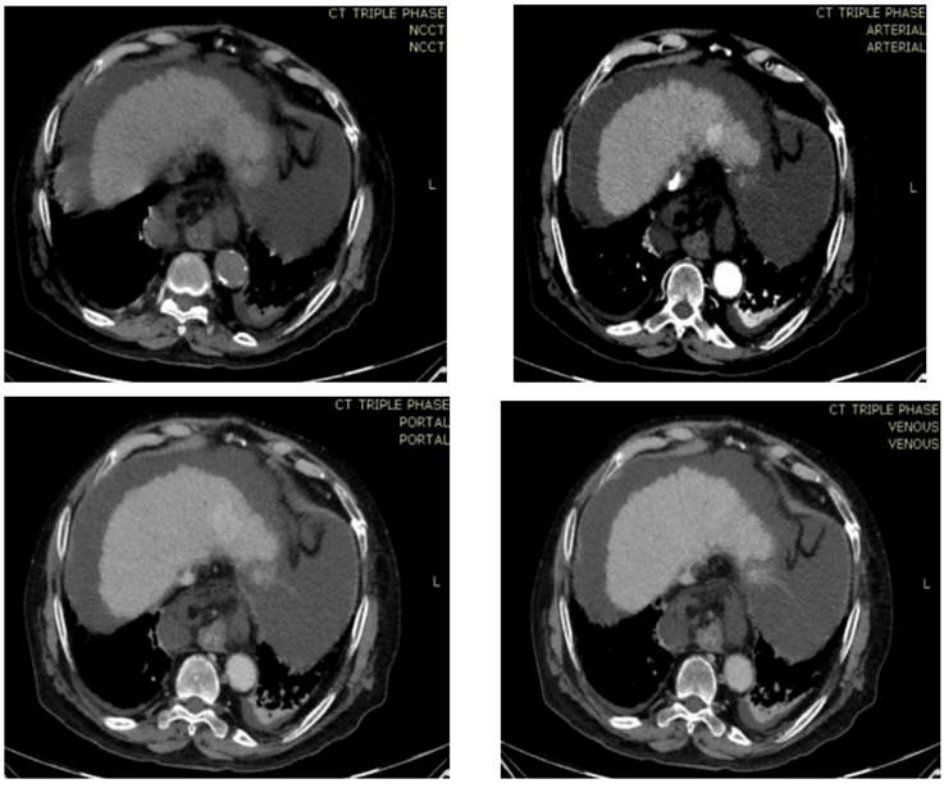
Sensitivity	Specificity	PPV	NPV	Accuracy
100	88.89	95.24	100	94.00

Out of a total of 40 cases assessed in the study, histocytopathology confirmed malignancy in 20 (50%) whereas 20 (50%%) were confirmed as benign cases. Triphasic CT detected 20 true positive, 1 false positive, none false negative and 19 true negative cases. Correspondingly, the sensitivity, specificity, positive and negative predictive values of triphasic CT for diagnosis of malignancy were 100%, 88.89%, 95.24% and 100% respectively. The method had an accuracy of 0.94.

Cases With Figures:

Hepatocellular Carcinoma

TRIPLE PHASE CT ABDOMEN: AXIAL NON-CONTRAST, ARTERIAL, PORTAL AND HEPATIC VENOUS PHASES- WELL DEFINED HOMOGENOUSLY ENHANCING LESION IN ARTERIAL PHASE WITH WASHOUT ON VENOUS PHASE



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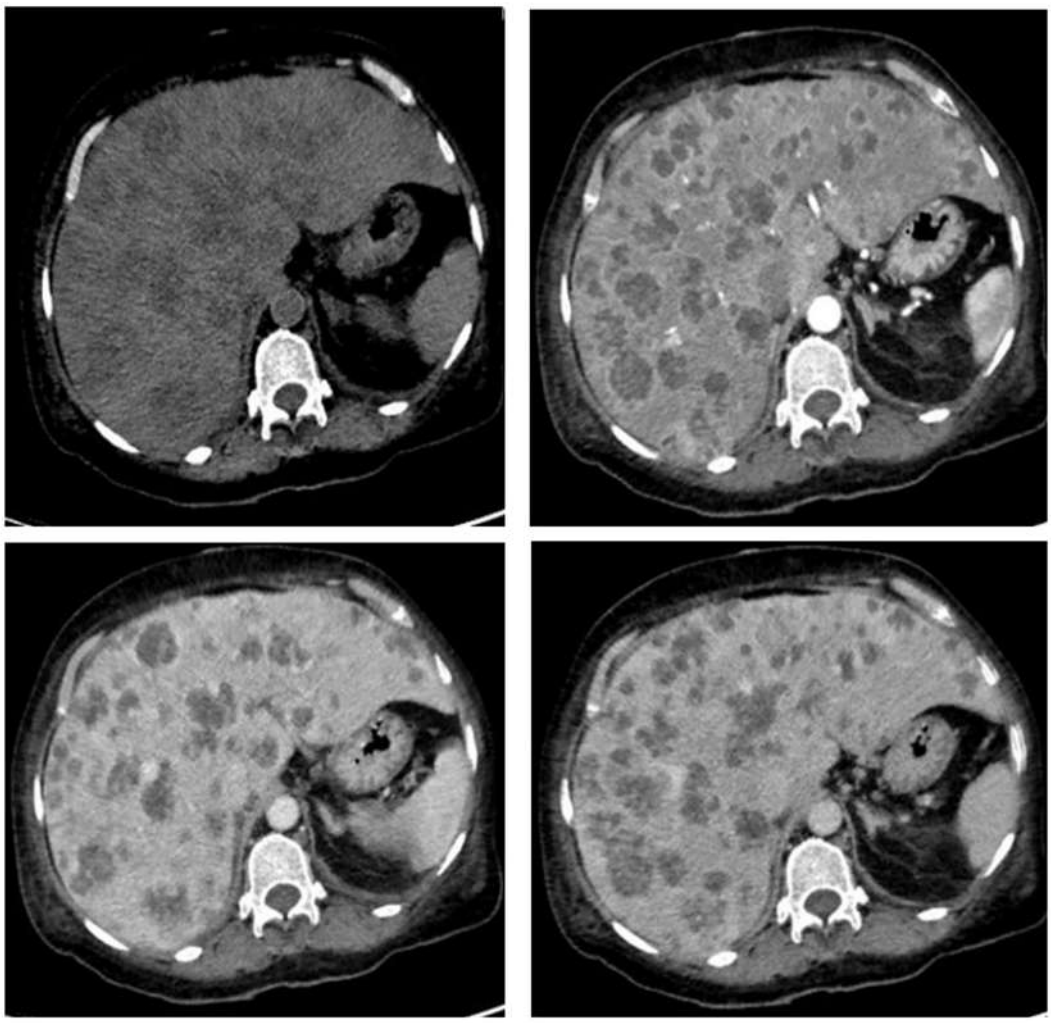
Metastasis

TRIPLE PHASE CT ABDOMEN: AXIAL NON-CONTRAST, ARTERIAL, PORTAL AND HEPATIC VENOUS PHASES-MULTIPLE IRREGULAR RELATIVELY WELL DEFINED HYPODENSE LESIONS IN THE LIVER, SHOWING HETEROGENOUS PERIPHERAL ENHANCEMENT ON ARTERIAL AND PORTAL PHASES WITH RELATIVE WASHOUT ON HEPATIC VENOUS PHASE.



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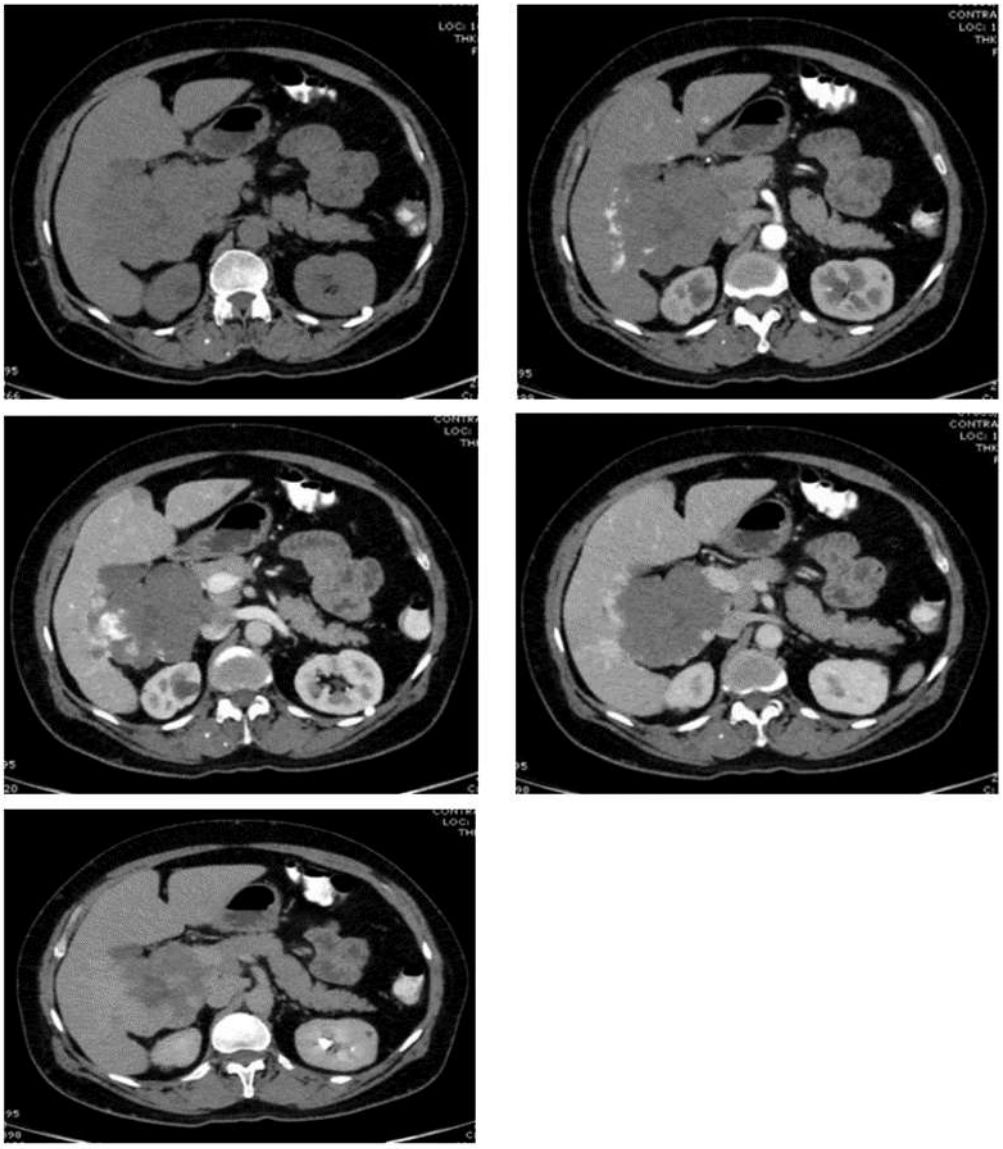
Hemangioma

TRIPLE PHASE CT ABDOMEN: AXIAL NON-CONTRAST, ARTERIAL, PORTAL,

HEPATIC VENOUS AND DELAYED PHASES: A LARGE RELATIVELY WELL

DEFINED HYPODENSE LESION, SHOWING PERIPHERAL NODULAR ENHANCEMENT ON ARTERIAL PHASE AND PROGRESSIVE CENTRIPETAL FILL IN ON SUCCESIVE PHASES



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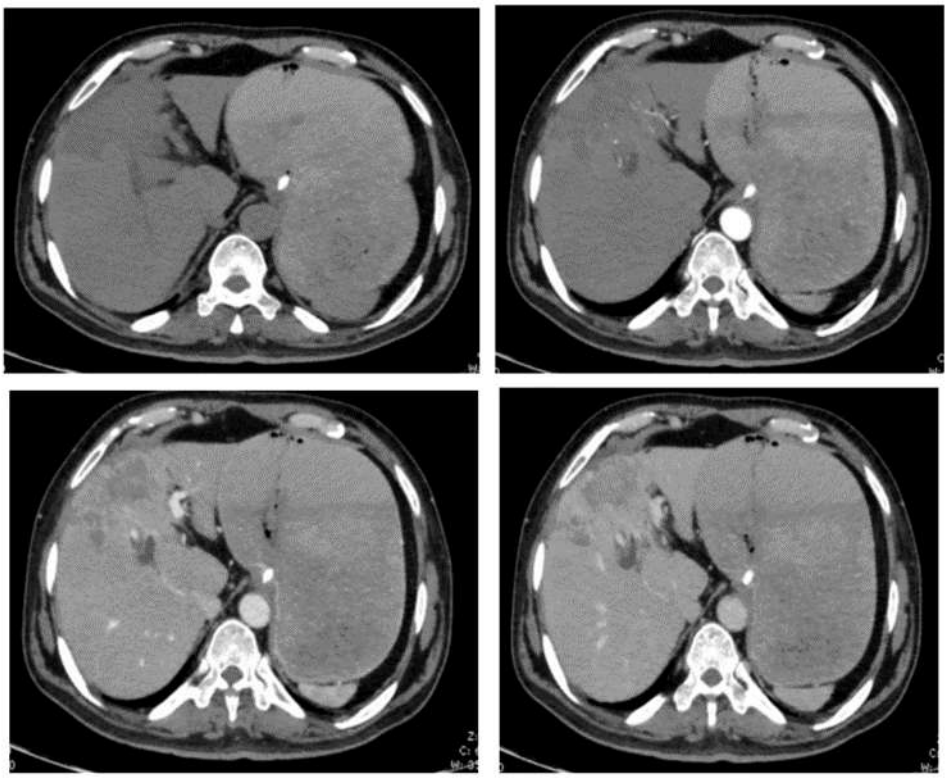
Gall Bladder Fossa Mass Infiltrating Liver



TRIPLE PHASE CT ABDOMEN: AXIAL NON-CONTRAST, ARTERIAL, PORTAL AND HEPATIC VENOUS PHASES- GALL BLADDER FOSSA SHOWS AN ILL-DEFINED HETEROGENOUSLY ENHANCING LESION IN ARTERIAL AND PORTAL PHASE WITH LOSS OF FAT PLANES WITH THE SURROUNDING LIVER PARENCHYMA

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