

Research Article

Role of triple phase computed tomography findings for evaluation of hepatic lesions

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ABSTRACT

Background: Liver is prone to various diseases including benign and malignant because of its major function of digestion, detoxification and rich blood supply by hepatic artery and portal vein. Objectives of the study were to study the characteristic features of various hepatic lesions using triple phase CT as diagnostic modality, differentiating benign hepatic lesions from malignant and correlating findings of triple phase CT with clinical, histopathology or post-operative findings for calculation of its efficacy.

Methods: A total of 100 patients were enrolled in this cross-sectional study done in Department of Radiodiagnosis, Gandhi Medical College, Bhopal, Madhya Pradesh, India. All patients underwent triple phase CECT examination and its accuracy, sensitivity and specificity was calculated.

Results: Triple phase CT be excellent diagnostic modality for characterisation and better evaluation of hepatic masses with sensitivity of 91.3% , specificity 97.8% , PPV 91.3% and NPV 97.8% (p value<0.001 , kappa value 0.847). Malignant hepatic lesions can be diagnosed by triphasic CT with accuracy of 93% , sensitivity and specificity of 93.3% and 92.5% respectively and with PPV and NPV of 94.9% and 90.2% respectively

Conclusions: Triple phase CT with high accuracy is helpful in confident diagnosis of a hepatic lesion. It has an indispensable role in characterizing, evaluating and differentiating benign and malignant hepatic lesions which helps in guiding appropriate management plan with proper surgical triage. It is also helpful in reaching primary malignancy diagnosis in cases of multiple liver metastases from unknown primary.

Keywords: Benign, Malignant, Hepatic masses, Arterial phase, Portal venous phase, Delayed phase, Triple phase CT

INTRODUCTION

Liver is prone to various diseases including benign and malignant because of its major function of digestion, detoxification and rich blood supply by hepatic artery and portal vein.^{1,2} Most primary and metastatic liver tumors, receives their blood from the hepatic artery , thus reverses the normal proportion of hepatic blood supply which is mainly supplied by portal vein (70%) to hepatic artery which becomes the prime source of blood supply.³ These difference in pattern of blood flow forms the basis of triple phase scan of liver. This technique has helped to elucidate the imaging features of primary and metastatic

liver tumors.⁴ Triple phase CT is very crucial in distinguishing a benign lesion from malignant to avoid unnecessary invasive procedures especially in benign tumors like hemangioma.⁵

Improved detection and characterization can help determine which hepatic tumors may be amenable to aggressive surgical techniques and which indicate palliative treatment. Few studies have elucidated its role and most of them have been on western population. This study purports to evaluate the triple phase CT features of common hepatic lesions with emphasis on the role of different phase imaging in characterization of these

lesions, so that diagnosing, staging and management of patients with liver pathology could be performed more effectively.

METHODS

This is hospital based prospective study of 100 cases. Study population included all patients with suspicion of hepatic masses on clinical, laboratory or Ultrasonography findings. Cases of all age groups were included irrespective of sex. Exclusion criteria was patients with renal failure or those with history of allergic reactions to contrast, pregnant and claustrophobic patients and focal liver lesions with infective etiology like hydatid cyst and liver abscess.

CT scans were done on CT/e Wipro GE machine. The study was approved by ethical and scientific committee of the institute and all the subjects were enrolled with detailed oral and written consents.

Technique

Triple phase CECT

Arterial phase was taken at 35-40 sec after contrast injection or 15-20 sec after bolus tracking. Lesions supplied by hepatic artery enhanced maximally in this phase .Hepatic or late portal phase was obtained at 70-80 sec after contrast injection or 50-60 sec after bolus tracking. Hepatic veins enhanced in this phase with maximal enhancement of hepatic parenchyma. Hypo-vascular lesions were best evaluated in this phase. 2-10 minutes after the contrast injection Delayed or equilibrium phase was obtained. Those tumors became visible in this phase that either loosed their contrast slower than normal liver parenchyma or washed out rapidly.⁴⁻⁷

Contrast agent used in the study was Diatrizoate-meglumine and Diatrizoate sodium 76% both orally and i.v. Water of low density oral contrast material, 1000 to 1500 cc was given 30 min prior to procedure. Dose of intravenous contrast varied according to weight of the patient (1.2-1.5 cc per kg) The injection rate was kept between 2.5-5 ml/sec, rate was adjusted as such that complete contrast is administered in approximately 30 sec. (for 125 mL of contrast with 4mL/sec and for 150 mL with 5mL/sec).

Statistical methods

Statistical analysis was done using computer software (SPSS IBM version 20). Qualitative data were expressed in proportion and percentages and quantitative data expressed as mean and standard deviations. Difference in proportion was analysed by using chi square test and difference in means were analysed by using student T Test [unpaired]. Significance level for tests was

determined as 95%. Thus difference was significant if p <0.05.

RESULTS

In present study, population comprises of cases with age ranging from 1 year to 79 years with the maximum number of cases in the age group of 41 to 50 years (30%). 54% of cases were males and 46% females.

Table 1: Age wise distribution of patients.

Age	No of patients	Percent (n=100)
<20	3	3.0
21-30	2	2.0
31-40	29	29.0
41-50	30	30.0
51-60	22	22.0
>60	14	14.0
Total	100	100.0

Table 2: Sex wise distribution of patients.

Sex	No of patients	Percent (n=100)
Female	46	46.0
Male	54	54.0
Total	100	100.0

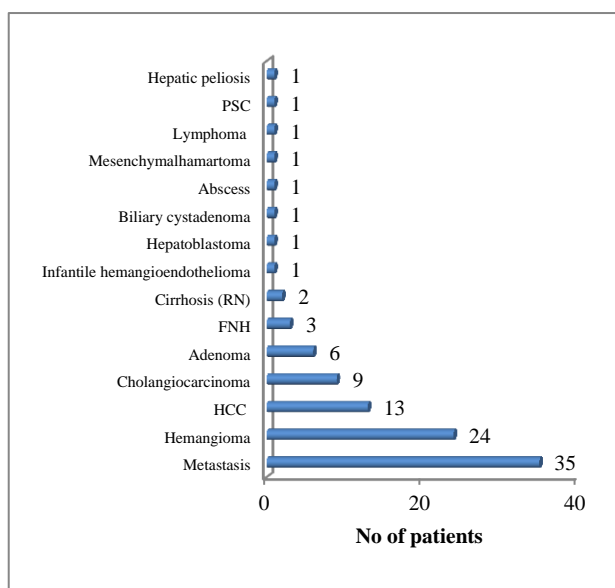


Figure 1: Diagnosis based on triphasic CT.

Largest group was formed by liver metastases with total 36 cases (36%). Majority of cases were in age group of 41 to 50 years (44.4%) followed by 51- 60 years (30.5%). Second largest group was of hemangioma with total number of 23 cases (23%) with majority of cases in the age group of 31-40 years (39.1%). Most common primary benign and malignant hepatic masses were hemangioma is 23% and HCC is 13% respectively.

Hemangioma was commonly seen in females (69.5%). While HCC is 76.9% and secondary liver metastases is 58.3% in males. Overall accuracy of diagnosing in hepatic mass by triphasic CT was 96.5%. Triple phase CT is excellent for characterization and better evaluation of hepatic masses with sensitivity of 91.3%, specificity 97.8%, PPV 91.3% and NPV 97.8% (p value<0.001, kappa value 0.847).

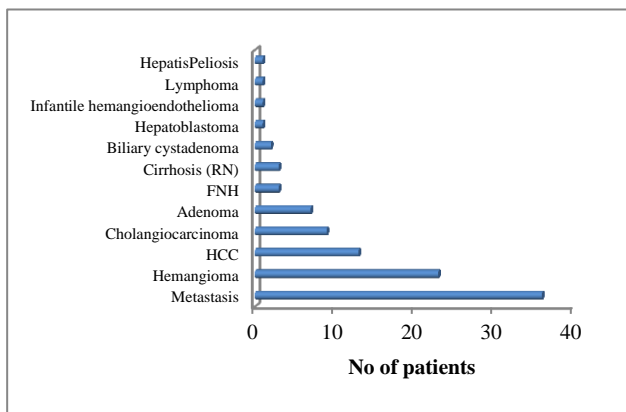


Figure 2: Final diagnosis as per histopathology report.

For better management of patients and proper surgical triage, benign lesions should be differentiated accurately and confidently from malignant. By this it can be determined that which patients demands surgery and which just needs follow up.

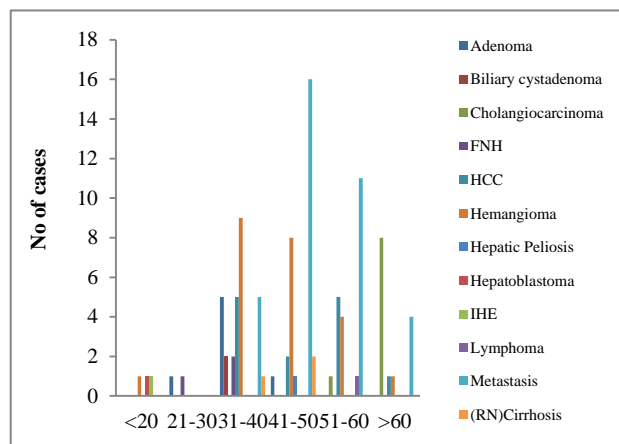


Figure 3: Age wise distribution of patients as per final diagnosis based on histopathology report.

Table 3: Presenting complaints of the patients in different hepatic lesions.

Final diagnosis	Symptoms							
	Asymptomatic	Abd distension	Abd pain	Fever	Hematemasis	Jaundice	Renal colic	Vomiting
Adenoma	0	3	3	0	0	0	0	1
Biliary cystadenoma	0	0	2	0	0	0	0	0
Cholangio-carcinoma	0	3	0	0	0	6	0	0
FNH	0	0	2	1	0	0	0	0
HCC	5	1	3	0	0	4	0	0
Hemangioma	7	2	5	5	1	2	1	0
Hepatic-Peliosis	1	0	0	0	0	0	0	0
Hepato-blastoma	0	1	0	0	0	0	0	0
IHE	0	1	0	0	0	0	0	0
Lymphoma	0	1	0	0	0	0	0	0
RN, Cirrhosis	2	0	0	0	0	1	0	0

There were 60 malignant and 40 benign tumors in the study. Among them 56 were diagnosed correctly on triphasic CT (94.9%). Malignant lesions can be diagnosed by triphasic CT with an accuracy of 93%, sensitivity and specificity of 93.3% and 92.5% respectively and PPV and NPV of 94.9% and 90.2% respectively. (p value <0.001, kappa value 0.855). Metastases could be differentiated as hypervascular,

hypovascular or cystic type based on triple phase CT characteristics. This further helps to define primary lesion, especially in cases of unknown primary.

33 cases of liver metastases were correctly diagnosed on triple phase CT (94.3%). For metastases, triple phase CT has diagnostic accuracy of 95%, sensitivity 91.7% and specificity 96.9% (p value <0.001, kappa 0.891).

22 cases were diagnosed correctly by triphasic CT (91.7%). It has accuracy of 97 %, sensitivity 95.7% and specificity 97.4% for diagnosing hemangioma (p value<0.001, kappa 0.917).

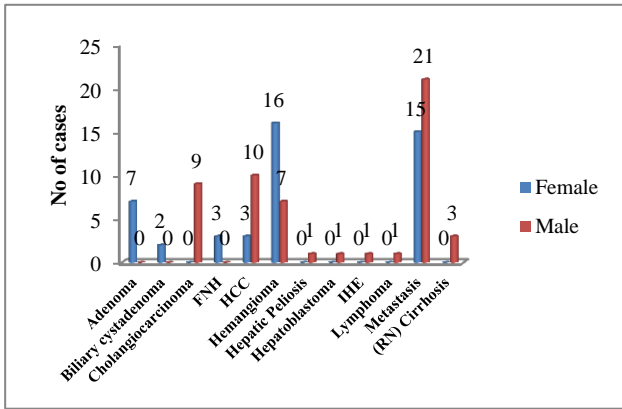


Figure 4: Sex wise distribution of patients in different hepatic lesions.

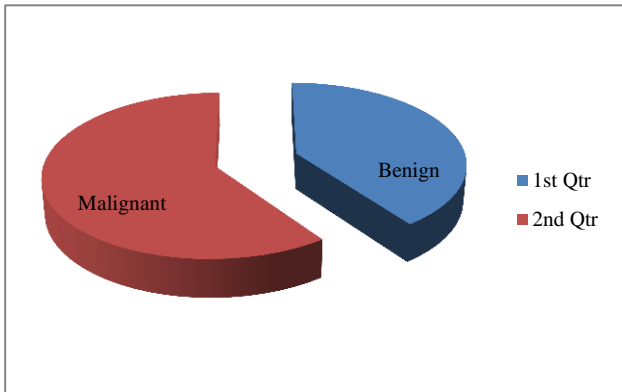


Figure 5: Total number of benign and malignant hepatic lesions obtained in the study population.

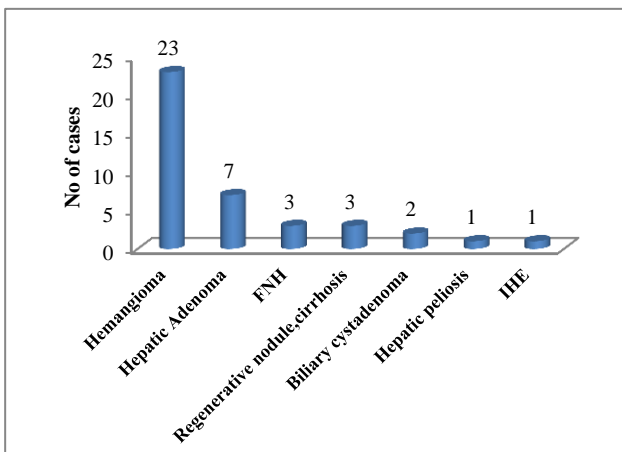


Figure 6: Total number of benign lesions obtained in the study population.

Maximum numbers of cases of Adenoma were in age group 31-40 years (71.4%). For hepatic adenoma,

Triphasic CT has diagnostic accuracy of 99%, sensitivity 85.7% and specificity 100% (p value<0.001, kappa 0.799). Maximum cases of Cholangiocarcinoma were in age group >60 years (88.8%). 8 were diagnosed correctly on triphasic CT. It has diagnostic accuracy of 98%, sensitivity 88.9% and specificity 98.9% (p value <0.001, kappa 0.823).

For HCC triphasic CT has diagnostic accuracy of 96%, sensitivity 84.6% and specificity 97.7% (p value <0.001, kappa 0.823). Vascular and anatomical details of tumor were better provided by triple phase CT which helped to plan neoadjuvant chemotherapy and surgical or image guided intervention.

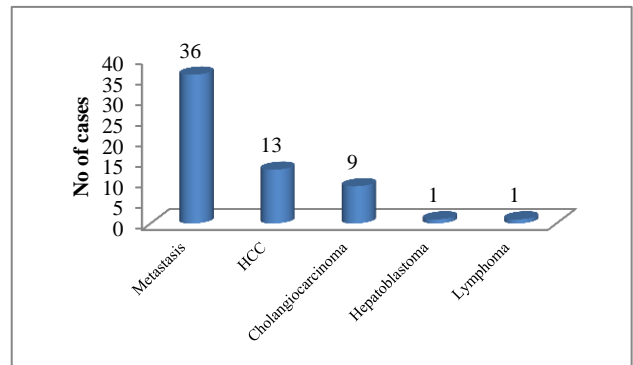


Figure 7: Total number malignant lesions obtained in the study population.

DISCUSSION

Hemangioma

In the study 16 cases were females and 7 males. Aytekin et al, have described that hemangioma are more common in females.⁸ Majority of lesions (90.9%) were of size less than 10 cm, only 2 lesions (9%) were more than 10 cm and maximum number of cases had single lesion. Mayo Foundation for Medical Education and Research, 2011 has described that most of the hepatic hemangioma are small, single and do not produce symptoms.

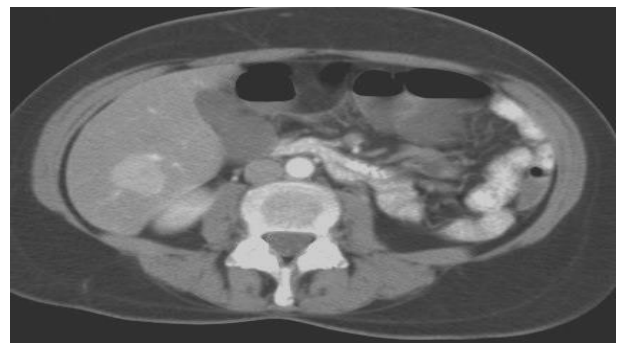


Figure 8: Hepatic adenoma, CECT abdomen reveals well defined lesion in the liver enhancing in the arterial phase.

17 cases were hypo dense (73.9%) on plain scan. On post contrast scans, all lesions (100%) showed enhancement in arterial phase (18 lesions demonstrated early discontinuous peripheral nodular enhancement while flash filling was seen in 6 cases) with progressive centripetal filling in portal venous and delayed phase. Central cystic areas were seen in 2 cases, both of size more than 10 cm. These findings were in agreement with those of Bartollota et al.⁹

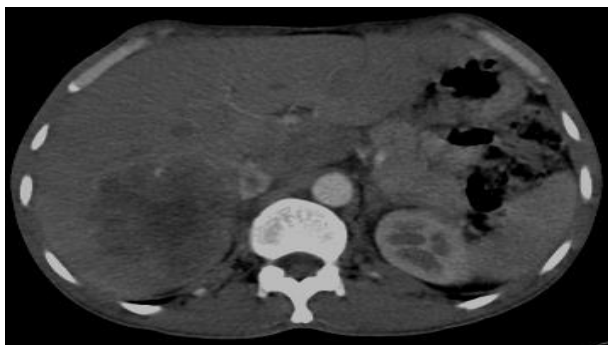


Figure 9: HCC CECT abdomen, showing heterogeneously enhancing lesion in arterial phase of triple phase CT.

In 2 cases of cirrhosis regenerative nodules were misdiagnosed as hemangioma on US but on triphasic CT they were correctly diagnosed as hemangioma. Although both are benign lesion and does not demand any surgical intervention. 1 case of hemangioma was misdiagnosed as adenoma on US, but on triple phase CT it revealed pathognomic features of hemangioma.

Out of the total of 4 benign lesions, 3 (75%) were correctly diagnosed on US. All the lesions were correctly diagnosed on CT. Out of 41 malignant lesions, 39 (95.12%) were correctly diagnosed on USG and 2 cases (4.88%) were misdiagnosed. Triple phase CT was able to correctly diagnose 40 malignant lesions (97.56%) and misdiagnosed 1 lesion (2.44%).



Figure 10: FNH, CECT abdomen reveals central enhancing scar of FNH in delayed phase of triple phase CT.

Adenoma

All the 7 cases were females (100%) and maximum in age group 31- 40 years (71.4%). All lesions were well defined (100%). On USG 4 lesions were hyper echoic (57.1%) and 3 hypoechoic (42.8%). A 36 year old female with history of hepatitis B since 4 years had well defined capsulated hypoechoic lesion in liver on USG which was diagnosed as HCC.

Lesion was hypodense on plain CT, in arterial phase lesion enhanced and became isodense in PV and delayed phase. Biopsy of the lesion was done and final diagnosis was adenoma. Hence, capsule can be present in both HCC and adenoma and should not be the differentiating criteria. According to Ichikawa T et al study, 2000 a thin tumor capsule can be identified in approximately 25% cases.¹⁰



Figure 11: CECT abdomen revealing multiple enhancing hypervascular liver metastases, in the arterial phase of triphasic CT.

FNH

All 3 cases were middle aged females (100%) and all lesions demonstrated well defined margins (100 %). In 38 year old female with history of Ca thyroid a hypoechoic lesion in liver was diagnosed as metastatic deposit on USG. On triple phase scan, lesion enhanced in arterial phase and became isodense in PV and delayed phases. Also enhancing central scar was seen in delayed scans. Diagnosis of FNH was made on CT which was later confirmed by histopathology. Thus lesion was misdiagnosed on USG but correctly diagnosed on CT. Similar findings were described by Blachar A, Federle MP, Ferris JV study, and Anderson SW study.¹¹

Another 25 year female had a small hypoechoic lesion in liver which was diagnosed as hemangioma on USG. On triphasic CT, lesion enhanced in arterial phase which persisted in portovenous phase and became isodense in delayed phase. FNAC was done on which final diagnosis was FNH. Lesion was misdiagnosed as other benign lesion, as central scar was not well appreciated in very small sized FNH. Hence, to conclude for very small sized FNH it is not necessary that scar will be visible in 100% of the cases.

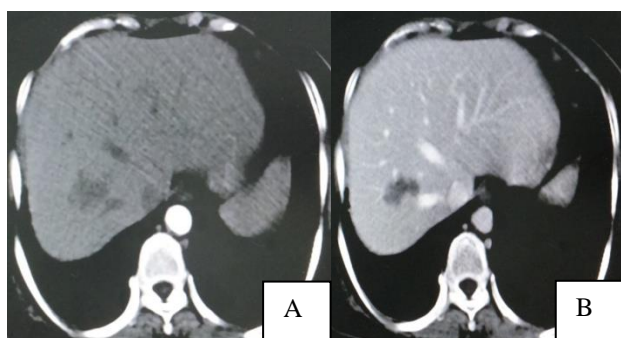


Figure 12 A and B: Hypovascular metastasis, CECT abdomen reveals ill-defined non enhancing lesion in liver in arterial phase which enhances in PV phase.

Infantile hemangioendothelioma

A 1 year old male presented with abdominal distension. He had a large heterogeneous hypo dense lesion on plain scan CT abdomen. On post contrast scans, in triple phase study, it showed early discontinuous peripheral enhancement on arterial phase with progressive centripetal fill-in on delayed phase. Additionally there was narrowing in calibre of infra celiac aorta.^{12,13}

Biliary cystadenoma

Both cases were middle aged females, in age group of 31-40 years. According to Levy AD Murakata LA study, biliary cystadenoma are predominantly seen in middle-aged females.¹⁴ 37 year old female with history of Ca ovary had a well-defined lesion in right lobe of liver which was diagnosed as cystic metastasis.

On CT, lesion demonstrated capsular enhancement in delayed phase. Final diagnosis was made as biliary cystadenoma on histopathology. According to Palacios E and Buetow PC, Midkiff RB study, on CT, they appears as a solitary cystic mass with a well-defined thick fibrous capsule. Capsular and septal enhancement is seen in post contrast scans.^{15,16} In present study also similar findings were encountered.

Hepatocellular carcinoma

12 cases had lesions with well-defined margins (92.3%) and 1 was with ill-defined margins. On NCCT, 8 lesions were hypodense (61.5%). All lesions showed early enhancement (100%) in arterial phase with rapid washout in Porto venous phase. All lesions were hypodense in delayed phase (100%). 10 lesions had capsular enhancement in delayed phase (76.9%). similar findings were described by Lee et al.¹⁷

9 cases had portal vein thrombosis (69.2%). Saini et al, has described that the tumor thrombus is another one of the characteristic features of HCC.¹⁸ Thus it was found that triple phase imaging with arterial, porto-venous and

delayed phases was advantageous in the evaluation of HCC

Hepatoblastoma

In a two year old boy who presented with complain of abdominal distension triple phase CT scan was performed. Lesion was hypodense on plain CT, demonstrated heterogenous enhancement in arterial phase and become hypodense in portovenous and delayed phases.¹⁹

Cholangiocarcinoma

All 9 cases were males (100%) and maximum (8 cases) in the age group greater than 60 years (88.8%). All the cases had jaundice and hyperbilirubinemia at presentation (100%). Bloom et al, has described similar features in their study.²⁰ All the cases in present study had single lesion (100%), 3 lesions were subcapsular and all had capsular retraction (100%). 7 lesions were hypodense (77.7%) and 2 isodense (22.2%) on NCCT and all cases (100%) demonstrated no enhancement in arterial and porto venous phase but were enhanced in delayed phase (100%). We had similar findings as described by Nisha et al.²¹

Metastases

Most of the cases (33 cases) had lesions showing well defined margins (91.6%). 12 cases (33.3%) demonstrated enhancement in the arterial phase among which peripheral continuous enhancement was seen in 5 lesions (41.67%) and complete in 7 cases (58.3%). 18 cases (50%) enhanced in portovenous phase. All of the lesions had rapid wash out of contrast and were hypodense in delayed phase. Foley et al, had described similar findings.²²

Lymphoma

A 52 year male had a well-defined hypoechoic lesion in the right lobe of the liver. Retroperitoneal and mesenteric lymphadenopathy was also noted. On USG it was diagnosed as metastatic deposit. Lesion was hypodense on plain CT and did not show enhancement in arterial and PV phase mild enhancement was observed in delayed scans after 10 minutes of contrast injection, it was diagnosed as lymphoma.

Diagnosis was confirmed on histopathology as lymphoma. Thus, lesion was misdiagnosed on USG but correctly diagnosed on triphasic CT. According to Fazelle et al, sonographically, it may either be multiple or solitary, hypo echoic or nearly anechoic mass.²³ According to Adonis Manzella et al the nodules are of low attenuation on plain CT and may show minimal enhancement.²⁴ Thus, triple phase CT has high accuracy of diagnosing a hepatic mass by triphasic CT-96.5%, value corresponding with Chauhan U et al, study.²⁵ It is

excellent for characterisation and better evaluation of hepatic masses with sensitivity of 91.3%, specificity 97.8%, PPV 91.3% and NPV 97.8% (p value <0.001, kappa value 0.847)

Findings

Triple phase CT proved to be an excellent diagnostic modality for characterisation and better evaluation of hepatic masses with sensitivity of 91.3%, specificity 97.8% , PPV 91.3% and NPV 97.8% (p value <0.001, kappa value 0.847).

Malignant hepatic lesions can be diagnosed by triphasic CT with accuracy of 93%, sensitivity and specificity of 93.3% and 92.5% respectively and with PPV and NPV of 94.9% and 90.2% respectively

CONCLUSION

Triple phase 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 lesions and also helped in reaching primary malignancy diagnosis in cases of multiple liver metastases from unknown primary.

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

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Ethical approval: The study was approved by the Institutional Ethics Committee

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