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Role of Ultrasonography and Triphasic Contrast-Enhanced Computed Tomography in Evaluation of Focal Hepatic Lesions.

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Abstract-
Introduction: Focal liver lesions are commonly encountered in day-to-day practise. However, they always prove to be controversial and a challenge in diagnosis many times. Advances in imaging leads to widespread and early detection of these lesions. In depth knowledge of the imaging characteristics can therefore prove beneficial for the management of the patients.
Aims and Objectives: To evaluate the role of ultrasound (USG) and Triphasic Contrast-Enhanced Computed Tomography (CECT) in diagnosis of focal hepatic masses and compare the ultrasound and CECT findings of focal hepatic masses and correlate with histopathological and surgical findings.
Material and Methods:100 patients were included in the study. All underwent ultrasound and triphasic contrast enhanced computed tomography. The diagnostic value of ultrasound was compared to those of CT. Final diagnosis was made after correlation with surgical findings, serological findings and histopathological examination. The data collected was analysed statistically by SPSS 20.0 software.
Results: Final diagnosis of focal hepatic masses were simple cysts (n=5), hydatid cysts(n=10), haemangiomas (n=11), hepatocellular carcinoma(n=5), abscess (n=45), cholangiocarcinoma (n=4). The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were 83.36%,96.09%,78.73%,97.27% and 94.5% respectively for USG and 86.93%,98.07%,87.07%,97.59% and 96.71% respectively, for CT at 95% confidence interval.
Conclusion: USG and CECT are the modalities having comparable specificity and sensitivity, CECT being slightly more accurate than USG in evaluation of focal hepatic lesions in atypical cases.
Key words: *Focal hepatic lesions, Abscess, Metastasis, Hepatic Cysts, Tumours.*

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I. Introduction

Focal liver lesions are one of the common causes of mortality and morbidity in India. It is commonly encountered in day-to-day practise and prove to be a diagnostic and controversial challenge in imaging nowadays. Advances in imaging such as ultrasonography (USG) and computed tomography (CT) have led to increase in detection of hepatic mass lesions. Ultrasonography is frequently used and often the first line investigation in evaluation of jaundice, pain in right side of abdomen and hepatomegaly. [1,2] Advantages of ultrasonography include its low cost, wide availability and safety, its ability to diagnose benign cysts and haemangiomas. Because of its ability to image in any oblique plane is equal or superior to CT and MRI in localizing lesions to an anatomic segment or sub segment of the liver. Sonography is unexcelled in showing the relationship of liver tumours to critical structures such as veins, bile ducts and arteries. [3]. CT is an indispensable imaging tool for the evaluation of focal hepatic lesions. It can help in determining the resectability of hepatic masses, planning of treatment and following the response to therapy and for guiding biopsy. Triphasic contrast-enhanced CT technique allows imaging of the entire liver in three phases, from the time of administration of contrast-arterial, portal and delayed phases. The present study was planned to investigate the

role of triphasic contrast enhanced CT along with ultrasonography in detection and characterization of focal hepatic lesions.

II. Materials and Methods

The study was conducted in our Department of Radiodiagnosis, Medical College Kolkata and Hospital over a period of one year between December 2020 and December 2021.A total of 100 patients were included in the study. Patients mean age was 34 years ranging from 2 to 82 years.

Inclusion Criteria-

1. Referred with strong clinical doubt of having hepatic mass lesion
2. Incidentally detected hepatic mass lesion on routine ultrasonography or CT scanning
3. known hepatic mass lesion for further evaluation
4. patients referred for USG or CT guided FNAC or aspiration.

Exclusion criteria-

1. Patients with proven hepatic invasion by adjacent malignancies (GB, hepatic flexure, antral etc.) were excluded.
2. Patients undergone any interventional procedure
3. Uncooperative patients
4. Patients known of contrast allergy.

The study was conducted after getting approval from Institutional Ethics Committee. Informed consent was taken from all participants. All the patients underwent ultrasonography with GE Logitech P9 and PHILIPS IU22 machine and triphasic contrast enhanced CT was performed with Phillips Brilliance 16p (16 slice) CT scanner. The findings were then analysed based on the morphology of lesion, its enhancement patterns and associated findings with clinical correlation. However, gold standard were histopathological studies. The two modalities were evaluated based on the statistical parameters by SPSS 20.0 software and tables are charts were prepared by MS Excel. The results were then compared with previous studies in the literature.

III. Results

The mean age of the study group was 34 years ranging from 2 to 82 years. Maximum patients were in the age group 30-50 years which constituted 60% of all patients. Males formed the majority in the study with M:F ratio 3:2.

Lesions	Number of lesions	Percentage of lesions
Primary benign tumours	16	16
Primary malignant tumours	10	10
Metastasis	29	29
Infective	45	45
Total	100	100

Table 1: *Tabulation of the percentage of focal hepatic mass lesions in the study.*

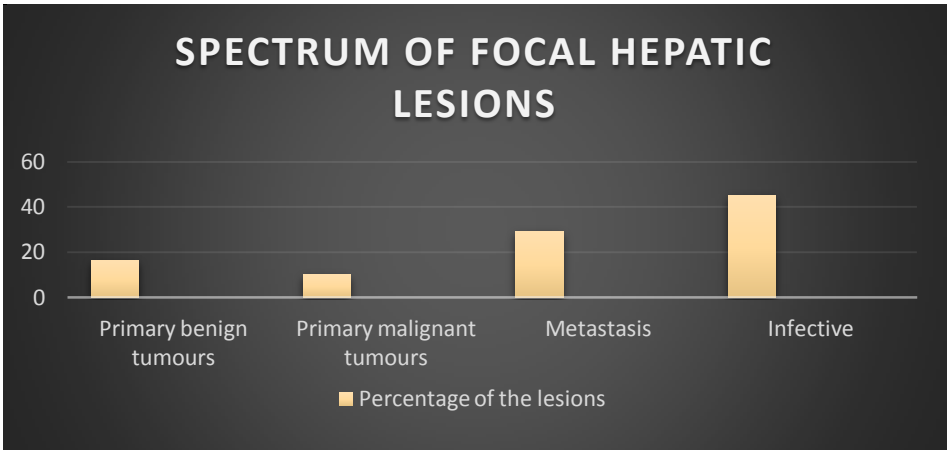


Table 2: *Spectrum of findings of focal hepatic lesions.*

Our study included primary benign tumours of liver (16%), primary malignant tumours of liver (10%), Metastasis (29%) and infective lesions formed the majority with 45 % of the patients (Table 1,2).

Infective lesions included pyogenic liver abscess (55.5%), amoebic liver abscess (22.22%) and hydatid cyst (22.2%). The findings were analysed and compared between the two modalities based on different criteria (Table 3). However definitive diagnosis was made by histopathology and culture studies.

Criteria		USG	CT
Wall thickness	Thick	28	22
	Thin	27	23
Wall appearance	Smooth	12	10
	Irregular	32	35
Internal Echoes		40	0
Septations		15	20
Air foci		30	32
Echotexture	Hypoechoic	40	38
	Hyperechoic	5	7

Table 3: *Characterisation of the abscess by USG and CT based on different parameters.*

Metastasis formed the second majority with 29% of the study population. Metastasis were observed to be either hyperechoic (9%) or hypoechoic predominantly (15%) or mixed (5%). Differentiation was better appreciated in USG than contrast enhanced CT in portal venous phase where hyper-vascular metastasis was iso attenuating to the liver parenchyma and difficult to detect.

In our study benign tumours of liver were mostly haemangiomas (70%). Others included simple liver cysts (30%). Mostly the patients were asymptomatic and it was an incidental finding.

Hepatocellular carcinoma (HCC) formed 5% of the primary malignant tumours of liver. Dynamic contrast enhanced CT proved useful due to its property of early enhancement and rapid washout. Portal venous thrombosis and findings of cirrhotic liver were associated findings. Hepatoblastoma (1%) was the most common malignant tumour obtained in childhood. Other cases included cholangiocarcinoma (4%). It was associated with dilatation of intra-hepatic biliary radicals and retraction of liver capsule in maximum of cases.

The lesions were compared with histopathology results and tabulated individually for ultrasound and CT (Table 4,6). Then the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the two modalities for individual focal hepatic lesions were assessed (Table 5,7) and the overall sensitivity, specificity and accuracy compared for both ultrasound and CT (Table 8).

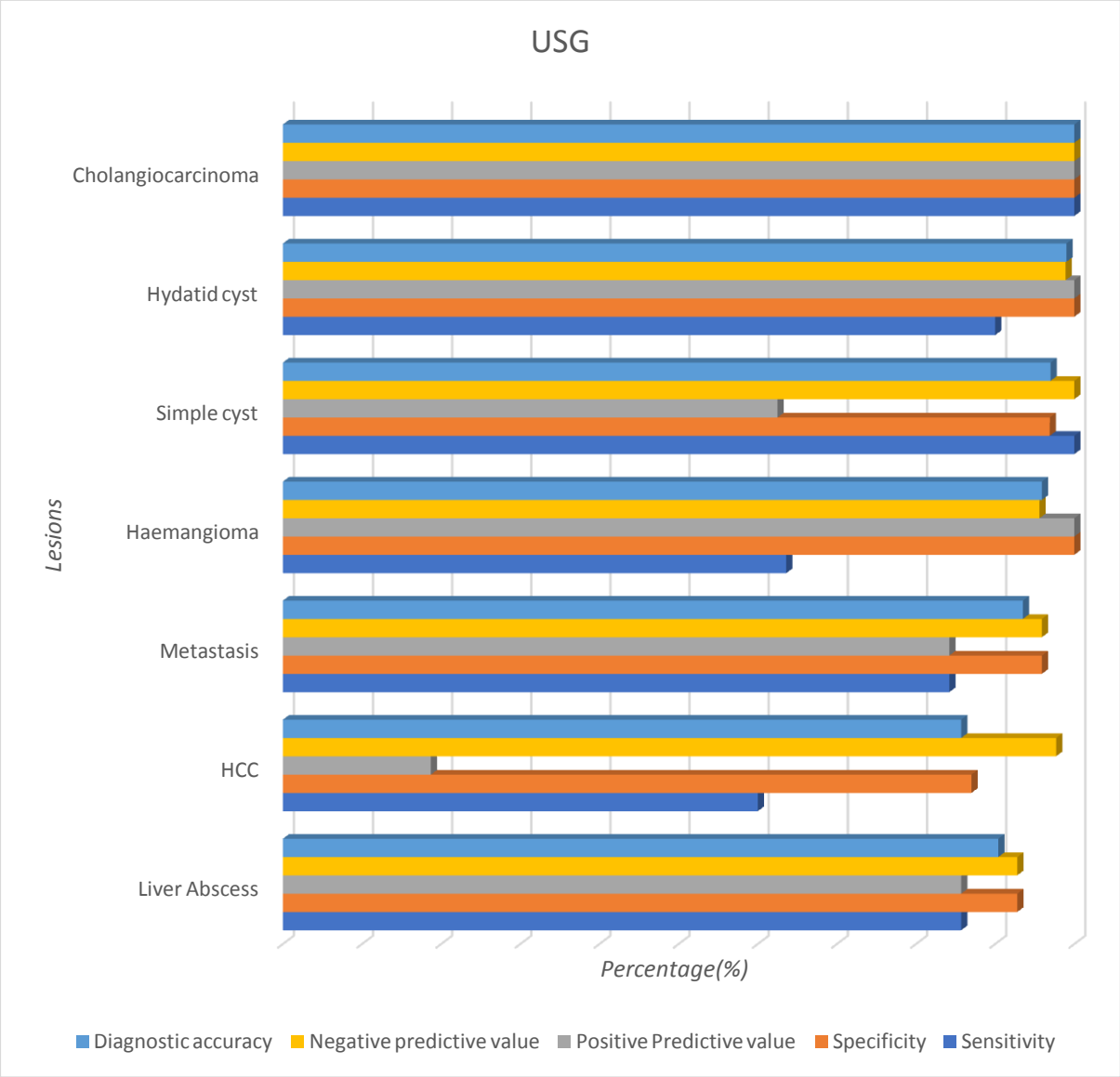
		USG							
		Liver Abscess	**HCC**	**Metastasis**	**Haemangioma**	**Simple Cyst**	**Hydatid cyst**	**Cholangio-carcinoma**	**Total**
FNAC +/- Biopsy	**Liver Abscess**	30	4			1			35
	HCC	1	3	1					5
	Metastasis	4	7	16		2			29
	Haemangioma		2	2	7				11
	Simple Cyst					5			5
	Hydatid cyst					1	9		10
	Cholangiocarcinoma							4	4
	Total	35	16	19	7	8	9	4	

Table 4: *Comparison of diagnosis between USG and histopathology standards.*

		FNAC+/- Biopsy													
		Liver Abscess		**HCC**		**Metastasis**		**Haemangioma**		**Simple cyst**		**Hydatid Cyst**		**Cholangiocarcinoma**	
USG		+	-	+	-	+	-	+	-	+	-	+	-	+	-
	Positive	30	5	3	13	16	3	7	0	5	3	9	0	4	0
	Negative	5	65	2	87	3	71	4	89	0	95	1	90	0	96

	Sensitivity	**Specificity**	**Positive Predictive value**	**Negative predictive value**	**Diagnostic accuracy**
Liver Abscess	85.7%	92.8%	85.7%	92.8%	90.4%
HCC	60%	87%	18.7%	97.7%	85.7%
Metastasis	84.2%	95.9%	84.2%	95.9%	93.5%
Haemangioma	63.6%	100%	100%	95.6%	95.9%
Simple cyst	100%	96.9%	62.5%	100%	97%
Hydatid cyst	90%	100%	100%	98.9%	99%
Cholangiocarcinoma	100%	100%	100%	100%	100%
Total	83.36%	96.09%	78.73%	97.27%	94.50%

Table 5: *Determination of the statistical parameters and diagnostic value of USG in evaluation of focal hepatic lesions.*



		CT							
	USG	**Liver Abscess**	**HCC**	**Metastasis**	**Haemangioma**	**Simple Cyst**	**Hydatid cyst**	**Cholangio-carcinoma**	**Total**
FNAC+/- BIOPSY	**Liver Abscess**	32				3			35
	HCC		4	1					5
	Metastasis		1	25	2	1			29
	Haemangioma		1		10				11
	Simple Cyst	1				4			5
	Hydatid cyst					2	8		10
	Cholangiocarcinoma							4	4
	Total	33	6	26	12	10	8	4	

Table 6: Comparison of the diagnosis between CT and histopathology standards.

		FNAC +/- Biopsy													
		Liver Abscess		**HCC**		**Metastasis**		**Haemangioma**		**Simple cyst**		**Hydatid Cyst**		**Cholangiocarcinoma**	
CT		+	-	+	-	+	-	+	-	+	-	+	-	+	-
	Positive	32	1	4	2	25	1	10	2	4	6	8	0	4	0
	Negative	3	65	1	87	4	71	1	89	1	95	2	90	0	96

CT	**Sensitivity**	**Specificity**	**Positive Predictive value**	**Negative predictive value**	**Diagnostic accuracy**
Liver Abscess	91.4%	98.4%	96.9%	94.2%	96%
HCC	80%	97.7%	66.6%	98.8%	96.8%
Metastasis	86.2%	98.6%	96.1%	94.6%	95%
Haemangioma	90.9%	97.8%	83.3%	98.8%	97%
Simple cyst	80%	94%	66.6%	98.9%	94.2%
Hydatid cyst	80%	100%	100%	97.8%	98%
Cholangiocarcinoma	100%	100%	100%	100%	100%
Total	86.93%	98.07%	87.07%	97.59%	96.71%

Table 7: Determination of the statistical parameters and diagnostic value of CT in evaluation of focal hepatic lesions.

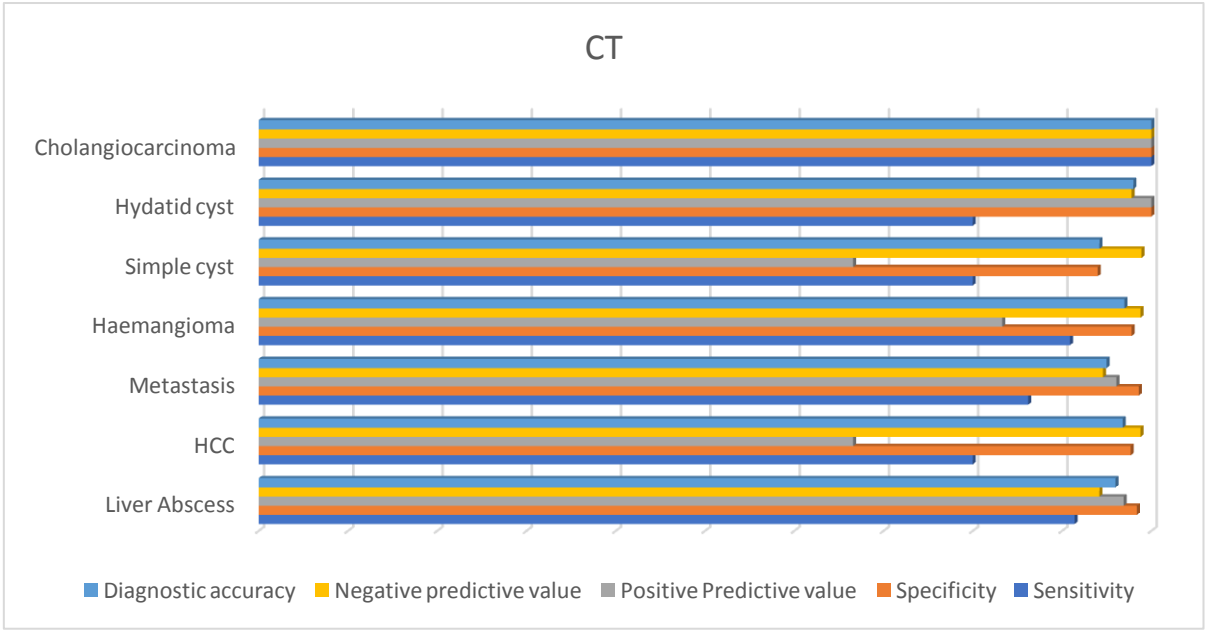
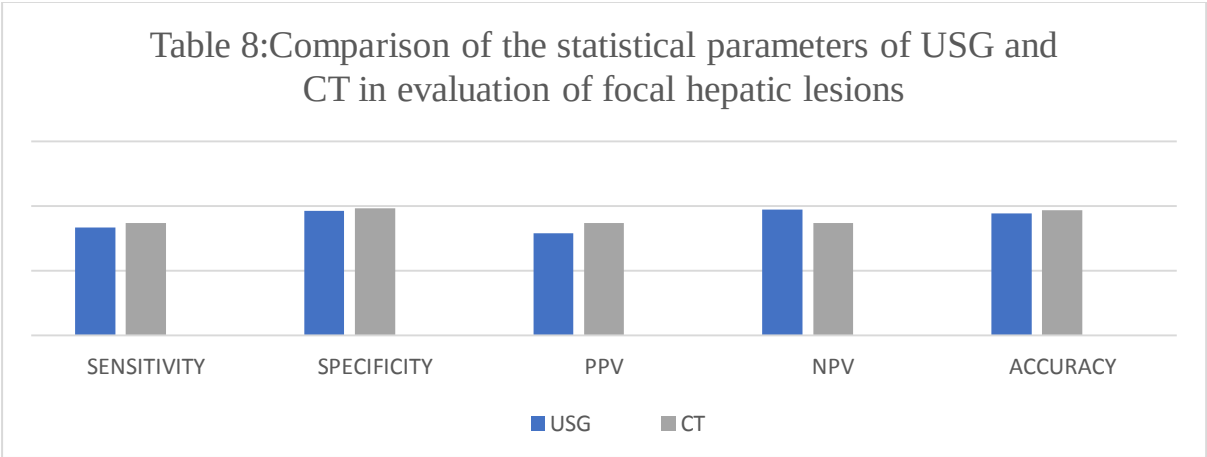


Table 8:Comparison of the statistical parameters of USG and CT in evaluation of focal hepatic lesions



IV. Discussion And Review Of Literature

Simple Liver Cysts-Most simple cysts were diagnosed incidentally on USG. The CT appearance of hepatic cysts are well-circumscribed, homogenous lesion of near-water attenuation value (20<HU), which shows no enhancement after IV contrast material administration [5]. In this study, there were only 5 cases of simple hepatic cysts, as these lesions are asymptomatic and usually detected incidentally. All the lesions were anechoic having thin imperceptible wall with posterior acoustic enhancement on USG. It was observed that USG was more specific and sensitive than CT in evaluation of simple cysts.

Hydatid cyst-

In this study we found 10 cases of hydatid cyst (22.22% of infective cases).2 cases were showing densely calcified wall. 2 patients (20%) were diagnosed as ruptured hydatid cyst having perihepatic collection with floating membranes seen in the collection and remaining 6 were having daughter cysts giving spoke wheel appearance. Imaging findings in hepatic hydatid disease depend on the stage of cyst growth (i.e., whether the cyst is unilocular, contains daughter vesicles, contains daughter cysts, is partially calcified, or is completely calcified [dead]). When detached from the peri-cyst the true cyst wall may appear as a thin wavy membrane within the fluid filled cyst [6]. This characteristic sign was appreciated in 60% cases of hydatid disease in this study. In the presence of typical imaging features like multiple daughter cysts, floating membrane and peripheral calcification, it was easy to diagnose hydatid cysts on USG and CT. (100%sensitive and specific on USG,80%sensitive and 100% specific on CT).

Figure 2A: Hydatid liver cyst: Gray scale 2D ultrasound showing an anechoic lesion with posterior wall enhancement with the characteristic" spoke wheel pattern" of multiple daughter cysts in right lobe of liver.
Figure 2B: Hydatid liver cyst: Axial CECT scan showing the corresponding cystic lesion with enhancing septations.

Abscess-

Ultrasonography is the preferred initial method of imaging for liver abscess as it is non-invasive, cost effective and can be used to guide aspiration to identify the causative organisms. Ultrasound will usually show a spherical oval or slightly irregular echo poor lesions with peripheral wall enhancement. This pattern is present in 80% of cases. In a study of 32 cases of hepatic abscess by *Abdelouafi A, Ousehal A, Vuzidane, Kadiri R et al* 1993[7]. 16 cases were found to be pyogenic liver abscess and remaining 16 cases to be amoebic liver abscess. All the patients initially underwent ultrasonographic examination. The confirmation of ultrasonographic diagnosis was made by ultrasound guided percutaneous aspiration in 30 cases and laparotomy in 2 cases. In this study 35 cases of hepatic abscess, 25 cases (71.4%) were of pyogenic liver abscesses and 10 cases were of amoebic liver abscesses.30 (85%) cases were having complaints of fever and pain abdomen. In this study also pyogenic abscesses were multiple in maximum cases and all amoebic liver abscesses were solitary. Amoebic liver abscess was larger in size than pyogenic abscess. Most of the lesions are hypoechoic (80% of amoebic and 20% of pyogenic abscess). The heterogenous aspect was found in 75% of amoebic and in 25% of pyogenic abscess. USG could better delineate the wall thickness and internal echoes while CT was better in detecting air foci and septations. Irregular wall was found in 75% of amoebic abscesses and in 50% of pyogenic abscesses. All the ultrasonographic results of this study were coinciding with studies in the literature. The characteristic CT appearance of hepatic abscess is that of a round or irregularly shaped hypo attenuating mass with a peripheral capsule that undergoes contrast enhancement [8]. Hepatic abscesses may be unilocular or multilocular. Smaller lesions <2cm may be seen clustering together with apparent coalescence into a large abscess ("cluster sign"), which is suggestive of their pyogenic nature [9]. (75% of cases in this study were positive for this finding and it appeared to be a strong indicator of the pyogenic nature of the lesion. The CT appearance of amoebic abscess is nonspecific. Extrahepatic abnormalities are common and include pleural effusion, perihepatic fluid collection,

gastric or colonic involvement, and retroperitoneal extension [10]**.** Right sided pleural effusion was detected in 40% of cases in our study. With the help of clinical picture, typical location and imaging appearances, a correct diagnosis was made in all cases.

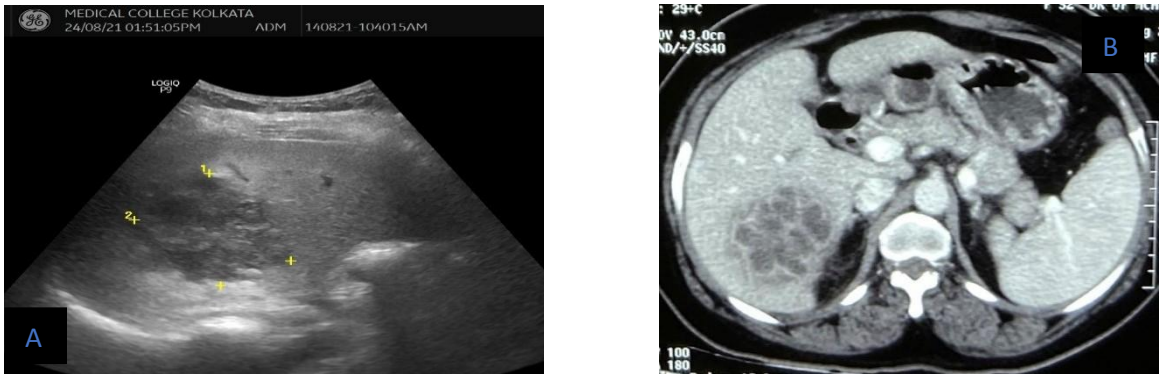


Figure 3A: Pyogenic liver abscess: Gray scale 2D ultrasound showing a solitary hypoechoic lesion with thick shaggy wall and internal echoes in right lobe of liver.
Figure 3B: Pyogenic liver abscess: Axial CECT scan showing the corresponding well defined hypodense thick-walled lesion with peripheral wall enhancement and typical clustered multiple similar lesions.

Haemangiomas-

It accounted for 11 cases (70% of the benign primary tumours of liver). The average size of cavernous haemangiomas was 2-3 cm, which was consistent with study of *Cherqui D. et al* who showed that these lesions are incidental findings and mostly less than 3 cm in size and these lesions shows homogenous hyperechoic pattern on ultrasound. However,2 cases were wrongly diagnosed to be haemangioma without history of primary and similar enhancement pattern. The lesion was hypo-attenuating in non-contrast CT but showed nodular discontinuous peripheral enhancement in late arterial phase and progressive centripetal fill-in in portal and delayed phases. The CT feature of nodular discontinuous peripheral enhancement was found to be more specific for differentiating hepatic haemangiomas from hyper-vascular metastases which showed rim enhancement on contrast enhanced CT [11]. USG is less sensitive but more specific than CT for evaluation of heamangiomas.

Hepatocellular carcinoma-(HCC) is the most common primary liver cancer comprising of 80% of primary liver malignancies [1] *Inge a et al* (2005)**11** al in their study, evaluated the appearances of HCC on ultrasound. In their study, HCC are hypoechoic in 48 % of the cases, isoechoic in 9 %, hyperechoic in 19 %, and in 25 % a mixture between hyper- and hypoechoic appearance was found compared to the surrounding liver tissue. In this study, on USG, in 4 (90%) patients, the lesions were hyperechoic. In only 1 patient lesion was iso-echoic. On triphasic-CECT scan, all patients followed the same pattern of enhancement in arterial and porto-venous phases (early enhancement in arterial phase, rapid washout in portal phase and capsular enhancement in delayed phases). We observed portal venous thrombosis in 2 (40%) cases in whom the tumours were large and infiltrative with a solitary enlarged nodule with multiple nodules surrounding it with considerable internal vascularity in a setting of cirrhotic liver.

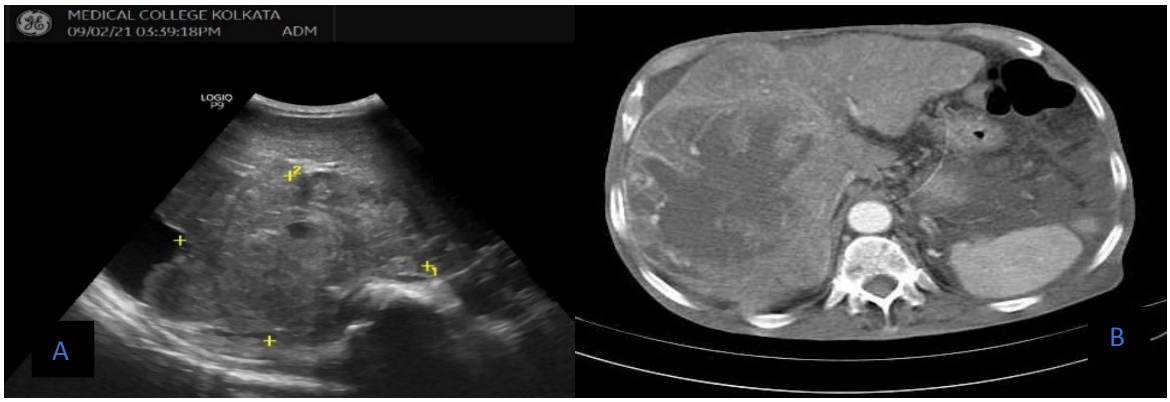


Figure 5A: Hepatocellular carcinoma: Gray scale 2D ultrasound showing a heterogenous hypoechoic lesion with peripheral hypoechoic halo in an irregular bordered shrunken liver.
Figure 5B: Hepatocellular carcinoma: Axial CECT scan in arterial phase showing the corresponding large ill-defined infiltrative heterogenous enhancing lesion with central non-enhancing hypodense area (suggestive of necrosis.)

Intra-hepatic Cholangiocarcinoma (IHCC)-
It is an adenocarcinoma that arises from the epithelium of small intrahepatic bile ducts. It is much less common than hepatocellular carcinoma, accounting for only approximately 10% of all primary
hepatic malignancies [12] IHCC was the second most common primary malignant neoplasm in this study as well 4 (40%) cases out of 10. Intrahepatic biliary ductal dilatation surrounding to the mass with capsular retraction were common findings. On USG, the lesion is hypo-vascular solid mass with heterogenous echotexture and may appear hypo, iso or hyperechoic with surrounding intra-hepatic biliary ductal dilatation [13]. The usual CT appearance is that of a hypo-attenuating mass with irregular margins and surrounding intra-hepatic biliary ductal dilatation with capsular retraction that shows mild irregular peripheral rim enhancement with central hypo-enhancement in arterial phase. There is washout in portal and delayed phases [12]**.** Similar findings were seen in cases including in this study.
There was only 1 case of hepatoblastoma in a 2-year-old boy. The USG appearance was of large hyperechoic mass with poor margins and irregular shaped calcify deposits The CT appearance of hepatoblastoma and hepatocellular carcinoma are similar.

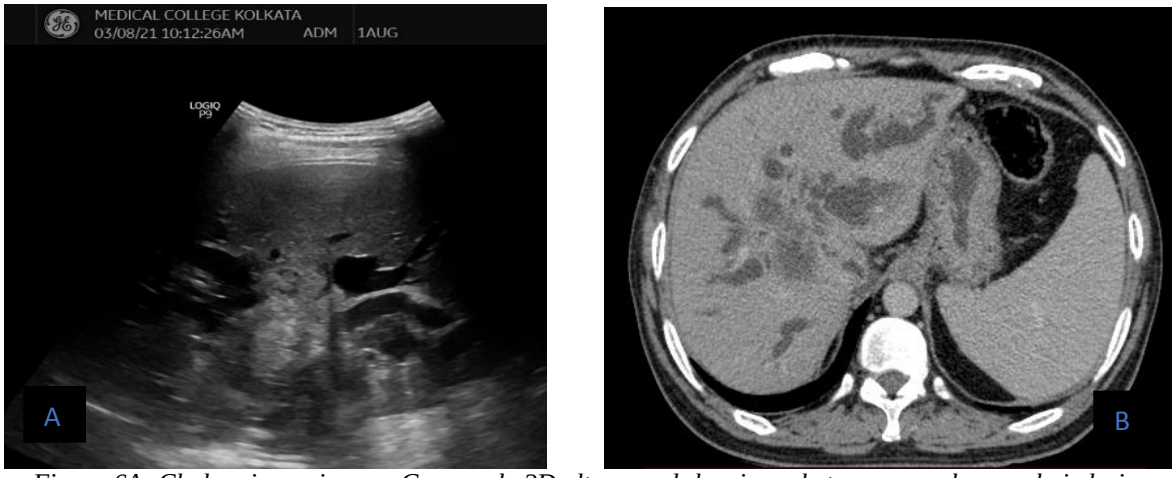


Figure 6A: Cholangiocarcinoma: Gray scale 2D ultrasound showing a heterogenous hyperechoic lesion at confluence of right and left common hepatic duct with peripheral intrahepatic biliary radical dilatation.
Figure 6B: Cholangiocarcinoma: Axial CECT scan in portal phase showing the corresponding ill-defined infiltrative heterogenous hypoattenuating mass lesion at confluence with peripheral intrahepatic biliary radical dilatation.

Metastasis-
Metastases occur 20 times more often than other malignancies in the non-cirrhotic liver [14] In this study metastatic disease comprised of 29 cases as compared to 10 of cases of primary malignancy,
which was consistent with other studies in literature. Most of the primaries were from GIT (80%) in our study similar to incidence mentioned in literature according to which the most common source of hepatic metastases is gastro-intestinal tumours (65%) [15]. Most metastases are hypodense relative to normal liver because these are hypo-vascular. Some metastatic lesions had a cystic appearance very confusing from simple cysts however they were thick walled and septated. This occurs characteristically, with ovarian tumours, carcinoma of the colon, teratoma and metastatic squamous tumours with an attenuation of <20 HU (e.g., colon carcinoma and carcinoma ovary) [16]. Other neoplasms having rapid growth leading to necrosis and a cystic appearance (e.g., lung carcinoma and sarcomas). 6 cases of cystic metastases two were from colon carcinoma and four were from carcinoma ovary were seen. 3 cases of calcified metastasis were observed out of which 1 was from gallbladder carcinoma and 2 were from colon carcinoma. Typical target like metastasis was commonly seen in association with colon carcinoma (90%). The lesions showed hypoattenuating on unenhanced CT, enhancing less than the surrounding liver following contrast. Enhancement is typically peripheral and rim-like, and although there may be central filling in, on portal venous phase, the delayed phase will show washout; helpful in distinguishing a metastasis from a haemangioma.

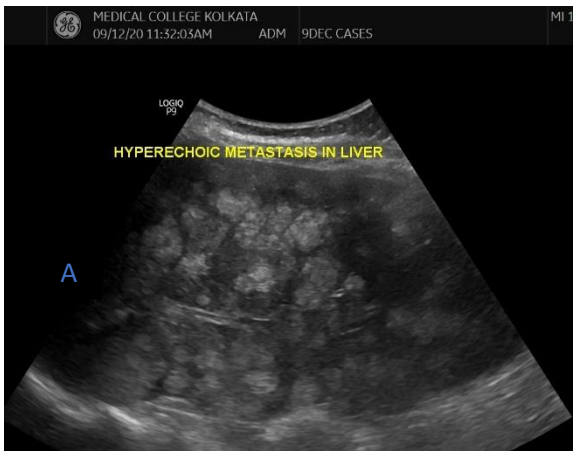


Figure 7A: Metastasis: Gray scale 2D ultrasound showing multiple hyperechoic lesions throughout liver parenchyma.

Figure 7B: Metastasis: Axial CECT scan in arterial phase showing multiple ill-defined hypoattenuating lesions with ill-defined rim enhancement, proven to be metastasis from gall bladder carcinoma after biopsy.

Triphasic CECT Feature	**Haemangioma**	**HCC**	**IHCC**	**Metastasis**
Arterial phase	Nodular discontinuous peripheral enhancement	Rim-like continuous Peripheral enhancement	Irregular peripheral enhancement with central hypo-enhancement(scar).	Rim-like peripheral enhancement
Portal phase	Centripetal filling-in of contrast	Rapid washout	Washout of contrast	Washout of contrast
Delayed phase	Centripetal filling-in of contrast	Capsular uptake of contrast	Washout of contrast	Washout of contrast
Biliary dilatation	No	No	Yes	No
Capsular retraction	No	No	Yes	No
Portal vein thrombosis	No	Yes	No	No

Table 9: To differentiate between haemangioma, HCC, IHCC and metastasis based on triphasic CECT features.

V. Conclusion

Infective variety of focal hepatic lesions form the most common entity that come to clinical practise. Metastatic masses are the most common malignant lesions of the liver. Primary benign lesions present clinically only when they are large or are detected incidentally on scanning for other reasons. Haemangioma can be confidently diagnosed on the basis of their characteristic echotexture and enhancement patterns especially on ultrasound. Liver cysts have typical appearance on USG as well as CT, both the modalities having high sensitivity and specificity. Hence, cysts are diagnosed by one modality further investigation may not be needed. In the case of metastasis and HCC, CT is superior to USG, as these lesions have specific enhancing patterns in triphasic CECT. Also, CT can accurately show the exact extent of a focal lesion and delineate adjacent organs. Imaging features of amoebic and pyogenic abscesses vary considerably on either modality and require needle aspiration cytology. However, subsequent to treatment, follow up is easier with USG. So, in essence, USG and CT are the modalities having comparable specificity and sensitivity, CT being slightly more accurate than USG in evaluation of focal hepatic lesions. In spite of the various advantages of CT over USG, in a developing country like ours, it may be judicious to use ultrasound first because it is widely available, cost effective, non-invasive and free from radiation. CT scan may be performed in atypical cases where ultrasound is not confirmatory and to know the exact extent of the lesion prior to surgery. As a follow up modality, in most situations, USG may be adequate.

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