Section: Radiodiagnosis

Original Research Article

A STUDY ON CORRELATION OF USG AND MRI FINDING IN FOCAL HEPATIC LESION

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Abstract

This study aimed to evaluate the usefulness of ultrasonography (USG) and magnetic resonance imaging (MRI) in detecting and characterizing focal liver lesions. A total of 80 patients with hepatic masses, including abscesses, hepatocellular carcinoma (HCC), metastasis, and hydatid cysts, were included in the study. USG, known for its affordability and accessibility, demonstrated good sensitivity in detecting hepatic lesions. It provided valuable information regarding lesion number, size, and location, as well as their relationship with critical structures within the liver. USG excelled in localizing lesions to specific liver segments and visualizing their association with veins, bile ducts, and arteries. In contrast, MRI offered superior spatial resolution and comprehensive imaging of the entire liver in a single scan. It played a crucial role in lesion detection and characterization by providing detailed images during different contrast enhancement phases. MRI was particularly effective in distinguishing various types of lesions, such as HCC, metastasis, and cholangiocarcinoma, based on their signal intensity and enhancement patterns. Comparing the two modalities, MRI demonstrated higher sensitivity and specificity in diagnosing liver lesions. It exhibited excellent performance in terms of sensitivity, specificity, positive predictive value, and negative predictive value, while USG showed slightly lower values. In conclusion, USG and MRI are valuable tools for detecting and characterizing focal liver lesions. USG's affordability and accessibility make it an excellent initial imaging choice, while MRI's superior spatial resolution provides detailed lesion characterization. The selection of the imaging modality depends on the specific clinical scenario and available resources.

INTRODUCTION

Detecting and characterization of focal liver lesions is one of the most confusing and controversial challenges in imaging today. A major problem is that all standard non-invasive imaging modalities are less sensitive than generally perceived. These sensitivity problems are no surprise to radiologists experienced in hepatic imaging, since focal hepatic lesions are frequently missed with one modality, then detected with another. [1]

The choice of imaging test largely depends on the clinical question, availability, the clinician's familiarity with the test and the patient's clinical condition.[3] In addition, access to critical clinical information remains extremely important. The most important clinical parameters defined include age and gender, clinical history, and symptoms.[4]

The main goals of imaging are to assess

1. The number and size of the liver abnormalities.
2. The location of abnormalities relative to the liver vessels.
3. The nature of the lesions (benign versus malignant).
4. The origin (primary versus secondary) of abnormalities.
5. The liver parenchyma surrounding the lesions.[5]

In cross sectional imaging, two basic issues related to a focal liver lesion: characterization of a known liver lesion and its detection.[6]

Imaging Modalities

Ultrasonography (USG)

Ultrasound is a fundamental technique for imaging the liver, biliary tree and gall bladder because it is inexpensive, easily available and widely accepted. Its advantages are speed and simplicity. Ultrasound

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is a safe and effective method of detecting focal liver lesions. Its flexibility, easy availability and lack of dependence on organ functions makes it most ideal for imaging the liver and also serves as an object of defining the therapeutic decision quickly. Sonography 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 subsegment of the liver. Sonography is unexcelled in showing the relationship of liver tumours to critical structures such as veins, bile ducts and arteries. In addition, sonography can be used for FNAC of these suspicious lesions that might obviate curative hepatic resection. Apart from detecting lesions, other valuable information like ascites, vessel involvement and primary source of malignancy in abdomen and pelvis can be easily obtained. Being a safe, simple, repeatable and without radiation exposure to the patient it is worthy in being included in routine diagnostic work.

In spite of the advent of the newer diagnostic modalities, it still holds a unique status even in current perspective.[7-8]

MAGNETIC RESONANCE IMAGING

MRI offers the better spatial resolution and the ability to study the entire liver in a single scan. It serves as a screening examination for the entire abdomen and pelvis with the use of organ specific coil. Recent technological advances in MRI technology have further improved the performance of MRI scanners in terms of speed of acquisition, resolution and the ability to image the liver during various phases of contrast enhancement just like contrast enhanced CT. Advances in image post processing and reconstruction methods are still under development. There is better delineation of the liver vascular anatomy to define the liver and tumour volume. MRI is a good diagnostic test because of its non-invasiveness and no ionising radiation interaction. As such no contraindications are seen to perform MRI. Its limitations include more scanning time, a low sensitivity for characterization of lesions and the test being expensive.[2] The present study assesses the usefulness of USG and MRI scan in depicting the status of various focal liver lesions and correlates them.

MATERIALS AND METHODS

Study Design: This prospective study was done in the Department of Radiodiagnosis. 80 patients of hepatic masses were included in this study. All patients presenting with right upper quadrant pain or space occupying lesions of liver i.e., developmental, neoplastic or inflammatory were included in the present study. All traumatic liver lesions were excluded from the study.

Statistical Analysis

The data was analysed statistically. Sensitivity and specificity of ultrasonography and magnetic resonance imaging were compared.

RESULTS

This prospective study was done in the Department of Radiodiagnosis. In present study there were 48 males and 32 females, with male to female ratio 3:2. 80 patients of hepatic masses were included in this study. Maximum number of patients presented with abdominal pain (32.5%) followed by fever in 25% of cases. Only 2.5% patients presented with jaundice. 7.5% of patients were asymptomatic at the time of presentation. The maximum numbers of patients were from age group 51-60 years comprising 25% of patients followed by patients in the age group of 61-70 years. Of the 80 patients studied, maximum cases were of hepatic abscess & Hepatocellular carcinoma 20 each (25%) respectively. Metastasis comprised of 17.5% of the total cases. Minimum number of cases belonged to cholangiocarcinoma, FNH and polycystic liver (2.5%).

Table 1: Types of hepatic masses

Types of Lesions	No. of Patients	%age
Abscess	20	25.00%
Cholangio Carcinoma	2	2.50%
Focal nodular hyperplasia	2	2.50%
Hepatocellular carcinoma	14	25.00%
Hemangiomas	6	7.50%
Hydatid cysts	8	10.00%
Metastasis	20	17.50%
Polycystic liver	2	2.50%
Simple cysts	6	7.50%
Total	80	**100.00%**

Table 2: USG features of hepatic abscess

		Amoebic	Pyogenic
No. of abscesses	Single	1	7
	Multiple (More than 1)	1	11
Site	Right lobe	1	11
	Left lobe	1	6
	Both lobe	0	1

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Size	Maximum	10x8 cm	11x10 cm
	Minimum	3x4 cm	1.8x1.8 cm
Shape	Irregular	1	11
	Round	1	7
Wall appearance	Irregular	1	11
	Smooth	1	7
Echotexture	Hypoechoic	2	10
	Hyperechoic	0	8
Posterior acoustic enhancement		1	9

Of the 2 cases of amoebic abscesses, one was found to be a single abscess while the other case was of multiple abscesses.

The distribution of the lesions was seen in both lobes. The shape varied from irregular shaped to round shaped. The wall appearance varied between irregular and smooth. The wall appeared thick on USG in both amoebic abscess cases. Posterior acoustic enhancement was noted in one case.

In the 18 cases of pyogenic abscesses USG detected 7 single and 11 multiple abscesses. 9 abscesses were detected by USG in the right lobe, whereas 4 were detected in the left lobe, while one abscess was seen to involve part of both left and right lobe. 16 of the pyogenic abscesses were irregular in shape while 9 were round in shape. The wall appearance was found to be irregular in 23 abscesses, while it was found to be smooth in 2 abscesses. Wall thickness was thick in most cases. 13 pyogenic abscesses were found to be hypoechoic while 12 were found to be hyperechoic with internal echoes. 9 pyogenic abscesses showed posterior acoustic enhancement.

Table 3: USG Vs MRI imaging features of hepatic abscess

		USG	**MRI**
Wall thickness	Thick	12	16
	Thin	8	4
Wall appearance	Smooth	12	15
	Irregular	8	5
Internal echoes		17	0
Fluid intensity in lesion on MRI		-	20
Internal septations/multiseptated		6	8
Air		0	1

On USG, 16 hepatic abscesses were found to be hypoechoic while 12 hepatic abscesses were found to be hypoechoic. The walls of 8 abscesses were echogenic.On MRI, all lesions showed fluid intensity within them. Also, 8 abscesses showed internal septations.

Table 4: Comparison of USG and MRI in assessment of hepatic lesions

Etiology	**USG and MRI Diagnosis**	**USG >Informative**	**MRI> Informative**	**USG &MRI Indeterminate**
Simple cyst	6	-	-	-
Hydatid cyst	8	-	-	-
Amoebic Abscess	2	-	1	-
Pyogenic Abscess	18	4	11	-
Polycystic liver	2	-	-	-
Cholangiocarcinoma	2	-	1	-
HCC	14	-	2	-
Metastasis	20	3	5	-
FNH	2	-	-	1
Haemangioma	6	-	4	-

Table 5: Final diagnosis with USG

Statistic	**Value**	**95% CI**
Sensitivity	84.38 %	67.21 – 94.72 %
Specificity	67.74 %	48.63 – 83.32 %
Positive Predictive Value	50.79 %	55.88 – 86.21 %
Negative Predictive Value	50.79 %	60.65 – 93.45 %

Table 6: Final diagnosis with MRI

Statistic	**Value**	**95% CI**
Sensitivity	100.00%	89.42 – 100 %
Specificity	97.14%	85.08 – 99.93 %
Positive Predictive Value	97.06%	84.67 - 99.93 %
Negative Predictive Value	100%	89.72 – 100 %

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DISCUSSION

The present study was undertaken to determine the relative role of USG and MRI in the diagnosis of focal hepatic masses of liver and also to assess if MRI had additional diagnostic value in the detection and characterization of these lesions. The results of imaging were correlated with the final diagnosis, which were obtained by surgery, with histopathology/ aspiration/ follow-up.

In present study, various aetiologies of liver lesions were seen. These included simple cysts, polycystic liver disease, liver abscess, hydatid cysts and cystic or necrotic metastasis. The commonest disease was found to be metastasis and abscess in 20 patients each.

Simple Cysts

In present study, simple cysts were seen in 6 cases (7.5%) in age group of 3 to 85 years. In present study on USG all the cases shows well circumscribed, round to ovoid shaped, anechoic lesions, with smooth margins, without discernible wall with posterior acoustic enhancement and sharp anterior and posterior border. On MRI, they were circumscribed, round to oval shaped, with well-defined margins, hypointense on T1 weighted images and hypointense on T2 weighted images, with no diffusion restriction.

In a study by Gaines et al [9], 43 cases (100%) showed that all the simple cysts had no wall abnormalities, internal septation or echoes, no post contrast enhancement on CEMRI images.

Hydatid Cyst

In present study, hydatid cysts were seen in 4 cases.

In present study, ultrasonography was 100% sensitive in detection of hydatid cysts. MRI demonstrated cysts with detached membranes in 20% cases. These detached, free-floating membranes, known as water lily sign, which is characteristic and pathognomonic of hydatid cysts.

In a study by Kalinova et al: USG was superior to MRI in demonstrating water lily sign and hydatid sand. According to them, other advantages of USG were it is safer, less expensive and readily available.

In present study, MRI was superior to USG.MRI demonstrated calcifications in 60% lesion. USG detected calcifications in only 40% lesions. MRI was superior in demonstrating the calcification.

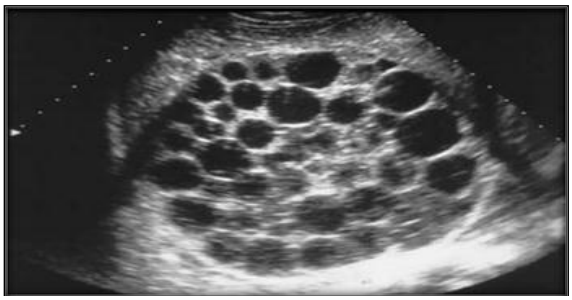

Figure 1 (a): USG image shows thin-walled cystic lesion in the left lobe of liver, with posterior acoustic enhancement

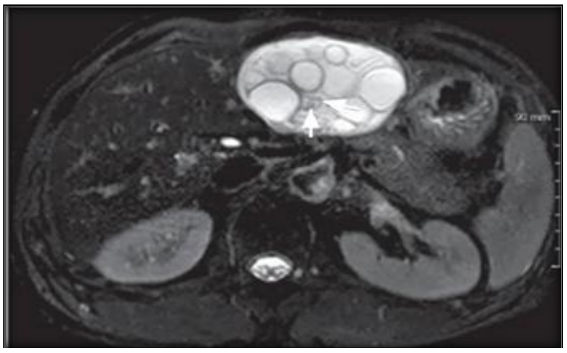

Figure 1 (b): Corresponding MRI image shows a large thin-walled hypodense lesion of fluid attenuation in the left lobe of liver

Liver Abscess

In present study there were total 20 cases (25%) of liver abscesses out of which 14 were males and 6 were females. A total of 18 pyogenic lesions were seen on USG, and on MRI scan. Most common presenting complaint was right upper quadrant pain. The result was comparable with study conducted by Alsaif et al [12] which included patients in the age group of 21-89 years. 94 were males and 37 were females. The most common presenting complaint was fever.

DWI in cases of hepatic abscesses show diffusion restriction within them depending on the cellularity content of the lesion. The lesion shows hyperintensity on diffusion images and shows low values on ADC images.

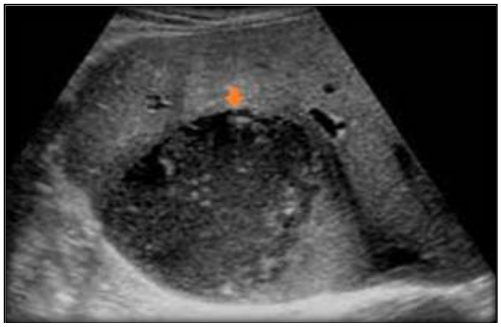

Figure 2 (a): USG showing thick-walled hypoechoic lesion with internal echoes and posterior acoustic enhancement

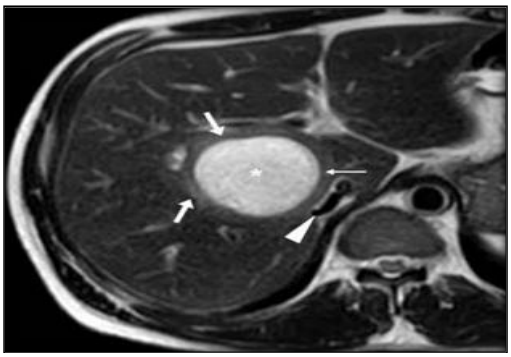

Figure 2 (b): Corresponding MRI scan showing a well-defined lesion with a thick wall in right lobe of liver which appears hyperintense on T2 weighted images

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Metastasis

In present study 17.5% of the lesions presented as mixed echo pattern on USG (Figure 3a). In a study conducted by Minami et al [13], the liver is the organ second most affected by metastatic disease. The most common primary sites are the gastrointestinal (GI) tract, lung, breast and head and neck. Therefore, liver metastasis varies in size, shape, vascularity, and growth pattern. However, most liver metastasis are multiple and show the so-called "target sign" or "bull's eye lesion". In present study 20 lesion of metastasis detected on MRI. The lesion appeared isointense on T1 weighted images and hyperintense on T2 weighted images. 12 lesions were found to be hyperechoic (Figure 3b), while 3 were found to be hypoechoic and showed mixed intensity on USG. Target appearance was seen in 14 lesions. USG incorrectly diagnosed 5 metastatic lesions as pyogenic abscesses.

Two lesions diagnosed as metastasis on USG were later found to be haemangiomas on MRI. A lesion diagnosed as HCC on both MRI and USG was later found to be FNH on histopathological examination.

In a similar study conducted by Sica et al [14], most metastasis are revealed as low- or isointense masses on MRI. Depending on lesion size, the margins tend to be irregular, and necrosis may be present, but margins can be sharp and well defined. Central low intensity may be the result of necrosis or cystic change.

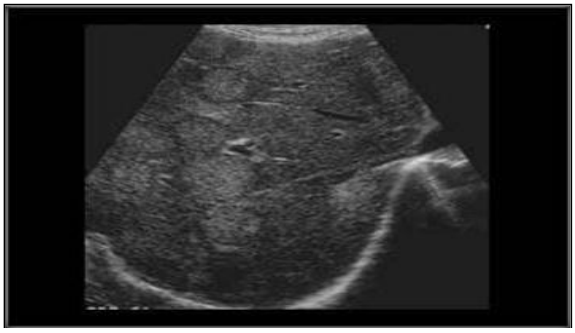

Figure 3(a): USG scan shows multiple rounds, heterogenous predominantly hyperechoic lesion with peripheral halo, in the right lobe of liver

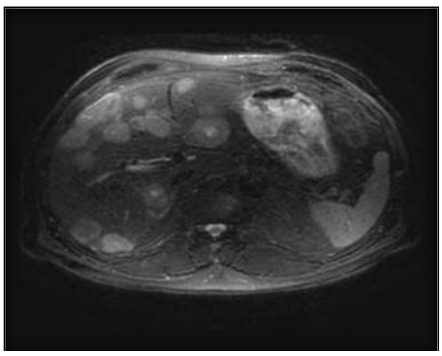

Figure 3(b): Corresponding MRI scan shows multiple well defined hyperintense lesions with internal hyperintense foci showing characteristic target sign in the both lobes of liver

Polycystic disease of liver

In present study 2 cases of polycystic liver disease were diagnosed. The patient was asymptomatic. Multiple cysts were seen in both lobes of liver on USG and MRI. In a study conducted by Everson et al[15], Polycystic liver disease in genetically linked to protein kinase C substrate 80K-H (PRKCSH). The cysts are more prominent in women, hepatic cysts emerge after onset of puberty and dramatically increase in number and size through the child-bearing years of early and middle adult life. Although liver failure or complications of advanced liver disease are rare, some patients develop massive hepatic cystic disease and become clinically symptomatic.

Haemangiomas

Haemangiomas are the second most common benign tumour of liver. On B-USG, they typically present as homogenously hyperechoic rounded lesions with distinct margins, sometimes with slight posterior acoustic enhancement. In present study 6 cases of haemangiomas were diagnosed (Figure4). The lesions on USG varied from mixed to solid appearance with hyperechoic echo pattern and shapes varied from irregular to round shape. On MRI the lesions were predominantly hypointense on T1 weighted images and hyperintense on T2 weighted images. The lesions appeared hyperintense on diffusion images and mixed signal intensity on ADC mapping. In a study conducted by Kumar et al [16] showed sharply defined highly reflective round tumor larger than 2.5cms showing posterior acoustic enhancement. MRI scan showed typical centripetal type of enhancement.

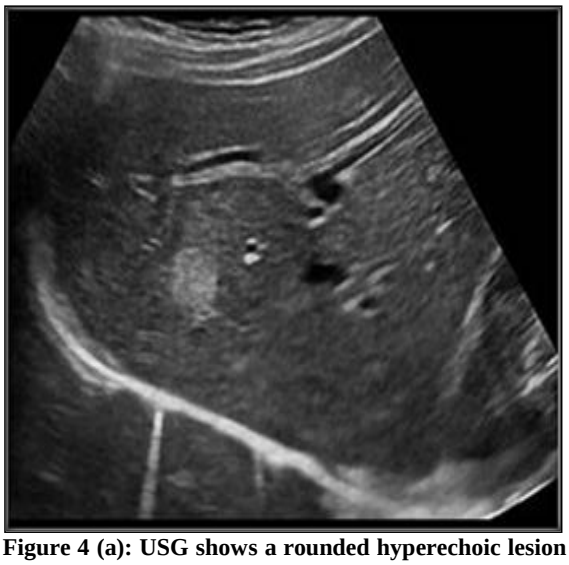

Figure 4 (a): USG shows a rounded hyperechoic lesion in the right lobe of liver

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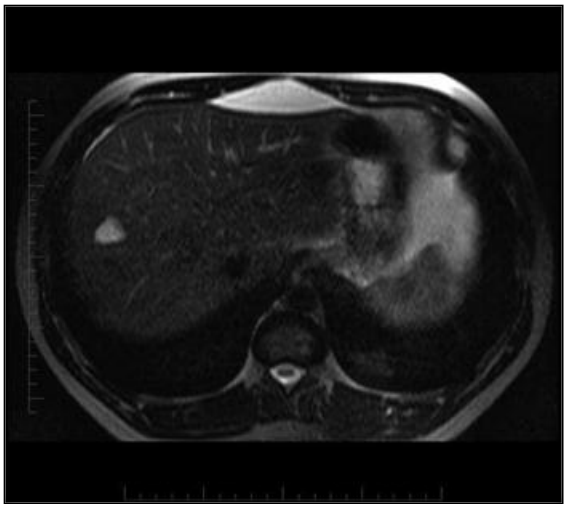

Figure 4(b): Corresponding MRI scan shows a rounded hyperintense lesion on T2 weighted sequence

Focal nodular hyperplasia (FNH)

In a study conducted by D'Onofrio et al [17], they found it is the most common benign lesion in liver. It cannot be defined as truly neoplastic lesion but rather a regenerative mass of variable size resulting from a vascular abnormality. The typical pathological feature is presence of large central scar in which are artery large them usual is located. In present study, 2 cases of FNH (Figure 5) was diagnosed on histopathological examination which ultrasound and USG incorrectly diagnosed as HCC. The lesion was found to be heterogenous predominantly hypoechoic with hyperintense scar. MR showed an irregularly hypointense lesion with central hypointense scar on T1 weighted images and hyperintense with central hyperintense scar on T2 weighted images.

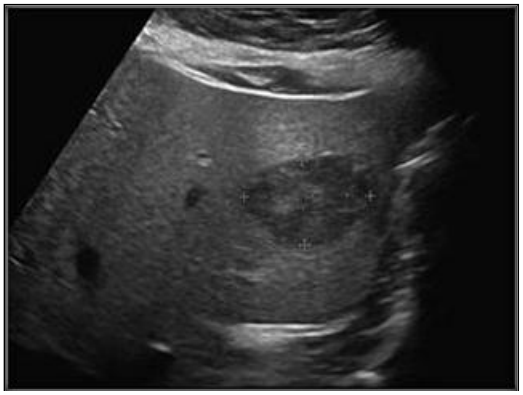

Figure 5 (a): USG shows a heterogenous predominantly hypoechoic mass with few hyperechoic areas in the right lobe of liver

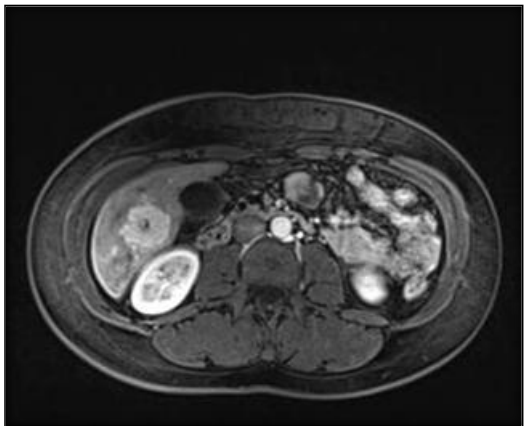

Figure 5 (b): Corresponding MRI image shows a hyperintense lesion with central hypointense scar in right lobe of the liver

Hepatocellular carcinoma (HCC)

In a study conducted by D'Onofrio et al [17] showed it is the sixth most common neoplasm and most common primary liver malignancy. Sine ours is a terminal institute, HCC is encountered in many patients in our study. In most cases, HCC develop victim an established background of chronic liver disease. USG is most common imaging modality for HCC surveillance in high-risk patients because of its efficacy, availability, non-invasiveness and low cost. However, Doppler applied to B-mode USG has low sensitivity in studying blood flow features within a newly discovered lesion.

In present study 14 lesions were diagnosed as HCC on USG (Figure 6a) and 12 lesions on MRI (Figure 6b). Out of 14 lesions diagnosed on USG 10 were found to be hyperechoic in echo pattern and 4 were hypoechoic and showed increased vascularity on colour doppler. whereas on MRI out of the 12 lesions 2 lesions were found hypointense on T1 weighted images and 10 lesions showed hyperintense lesion on T2 weighted images. The lesion showed hyperintensities on STIR images. 7 out of the total 12 lesions showed diffusion restriction in the lesions on DWI sequences due to increased cellular content.

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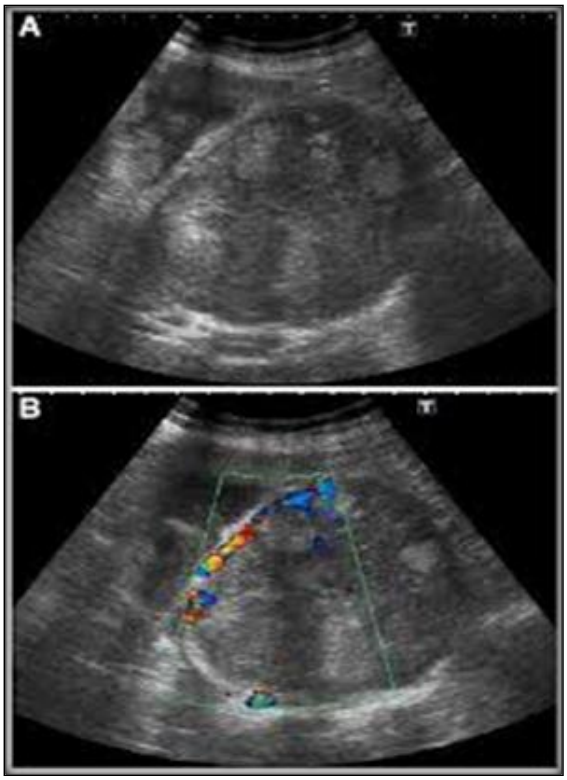

Figure 6 (a and b): USG image shows a large heterogeneously hyperechoic mass lesion in the right lobe of liver with peripheral intense vascularity

Cholangiocarcinoma

The incidence and modality are increasing because of the late clinical presentation with nonspecific symptoms and lack of effective nonsurgical therapy. On conventional B-mode USG, it usually appears as an ill-defined irregularly hypoechoic mass (Figure 7a). In present study a single hypoechoic, irregularly shaped lesion with peripheral vascularity on USG was incorrectly diagnosed as HCC on USG, while the same lesion was seen as having heterogeneous intensity on MRI (Figure 7b). And the other lesion was diagnosed to be cholangiocarcinoma on both modalities. Dilated intrahepatic biliary radicals were seen on both modalities as a characteristic finding of the holangiocarcinoma.

Figure 7 (a): USG shows hyperechoic mass lesion in the right lobe of the liver near the gall bladder fossa with dilated IHBR (not shown in the image)

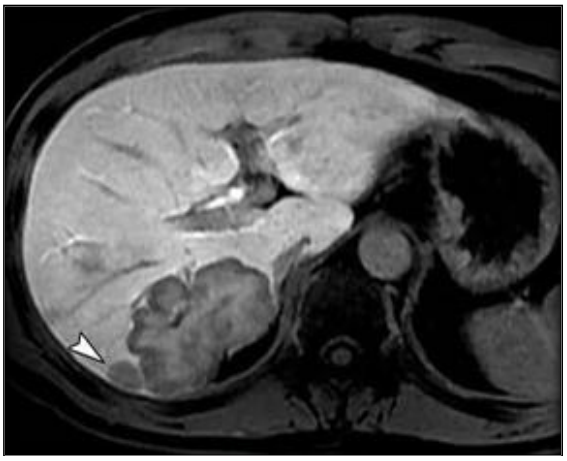

Figure 7 (b): MRI shows evidence of hypointense lesion with satellite nodule exactly adjacent to the lesion with dilated IHBR

CONCLUSION

Liver cysts have typical appearance on USG as well as MRI, 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, haemangiomas, HCC and cholangiocarcinoma, MRI is superior to USG, as these lesions have specific appearance and better spatial resolution with better characterisation of the extent of the disease. Also, MRI can accurately show the exact extent of a focal lesion and delineate adjacent organs. Also, it is non-invasive and no ionising radiations are used. Hence it can be safely used in paediatric patients as well as pregnant females. Imaging features of amoebic and pyogenic abscesses vary considerably on either modality or require needle aspiration cytology. However, subsequent to treatment, follow up is easier with USG. So in essence, USG and MRI are the modalities having comparable specificity and sensitivity. MRI gives better delineation of the parenchyma than the 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. MRI 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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