Original article

Ultrasound and MRI evaluation of hepatobiliary tumors with histopathological correlation

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Abstract

Introduction: Ultrasound is the first modality of choice for the diagnosis of Hepato-biliary diseases. Color Doppler is used to assess the vascularity of the Hepatobilliarytumour. Ultrasound is also used as a guide to FNAC of the Hepato-biliary tumours. Indications for the MRI of Hepato-biliary system include: (i) Characterization of lesion intensity. (ii) Determination of the extent and segmental localization of hepatic malignancies prior to planned liver resection. (iii) MRCP is being established as a non-invasive method for assessment of biliary system.

Materials & Methods: A prospective study of 42 patients with signs and symptoms suggestive of right upper quadrant masses or pain. Following this Ultrasonography and MRI, FNAC & biopsy was done and was sent for histopathology.

Results: On Ultrasound imaging 27 lesions (64%) should have been malignant and 15 cases (36%) should have been benign. On MRI 17 cases (77%) should have been malignant and 5 cases (23%) should have been benign. But FNAC was done in 23 cases only who had a normal coagulation profile. Out of these 23 malignancy was proved in 22 cases (96%). Thus MRI and Ultrasound have almost equivalent results in hepatic and gall bladder masses while significant difference was seen in diagnosing cholangiocarcinoma.

Conclusion: MRI and ultrasound have equivalent results in diagnosing hepatic and gall bladder masses but significant difference was seen in diagnosing cholangiocarcinoma.

Keywords : Ultrasound, MRI, Hepatobiliary Neoplasm

Introduction

Ultrasound is the first modality of choice for the diagnosis of Hepato-biliary diseases. The accuracy of an Ultrasound depends on a trained sonographer, as Ultrasound is an operator dependent. Advantages of Ultrasound are: (i) Easy and quick workup. (ii) Cost effective. (iii) Excellent for screening biliary obstruction and gall bladder disease. (iv) Non-ionizing radiation. (v) Portability (1).

On Sonographic study there is a considerable overlap in the appearances of focal liver mass, this includes: (i) Hypoechoic Halo margin visualized around an echogenic or isoechoic liver mass, is an ominous Sonographic sign necessitating definitive diagnosis. (ii) A hypoehoic liver mass is likely to be significant and requires further evaluation. (iii) Multiple solid liver masses may be significant and raise the possibility of multi-focal malignant liver masses either primary or secondary (1). In

advanced cirrhosis imaging is thought to be appropriate for identifying the slow growing tumour (Hepato-cellular carcinoma) and also for assessment of biliary trees (2).

Indications for the Magnetic resonance imaging (M.R.I.) of Hepato-biliary system include: (i) Characterization of lesion intensity. (ii) Determination of the extent and segmental localization of hepatic malignancies prior to planned liver resection. (iii) Magnetic resonance Cholangio-pancreaticography (M.R.C.P.) is being established as a non-invasive method for assessment of biliary system. The disadvantages of MRI scans are: (i) It is very expensive. (ii) Some patients because of claustrophobia, cannot co-operate for MRI scan (3).Magnetic Resonance Imaging is best for liver lesion detection and tissue characterization as it provides better resolution. Various contrast agents (Gadolinium chelates and Super Paramagnetic iron oxides) are used to image the liver. These contrast agents are useful in characterizing specific liver tumours as Focal Nodular Hyperplasia, Hepatic Adenoma and Hepatocellular Carcinom (3). Magnetic Resonance Cholangio-pancreaticography (MRCP) has the capability of evaluating bile ducts both above and below the stricture. It was found that MRCP was superior in defining anatomical extent of tumours, in comparing MRCP and Endoscopic Retrograde Cholangio-pancreaticography (ERCP).

Anatomy of Biliary Tree

A. Intrahepatic bile duct anatomy

Bile drains from the ductular and canalicular network of the acini. These ducts run with the branches of portal vein and hepatic vein in the portal triad. The smaller interlobular ducts join to form the septal bile ducts and these finally unite to form the left and right hepatic ducts .The right and left ducts drain bile from both lobes and the caudate lobe drains into both ducts (1).

B. Extrahepatic bile duct anatomy

The right and left hepatic ducts fuse at the hilum to form the common hepatic ducts. This is joined by the cystic duct to form the common bile duct. Both common bile duct and pancreatic duct unite and open into the ampulla of vater in the second part of duodenum. The gall bladder, which acts as a reservoir of bile, lies in the gallbladder fossa. Rarely it may be embedded in the liver parenchyma (1).

Aims and objectives

1. To study the role of ultrasonography (including color Doppler) and MRI in the diagnosis of various hepatobiliary tumours.
2. To compare the gray scale sonographic findings including color doppler findings with MRI findings and correlate them with histopathological findings.

Materials and methods

The study was carried out over a period of 12 months in the department of Radiodiagnosis. 42 Patients with signs and symptoms suggestive of right upper quadrant masses or pain were included in the study. A complete history of patient and detailed clinical examination of the patient was done after obtaining the informed consent of the patient.

Following this, Ultrasonography and MRI studies were done. Ultrasonography and color Doppler was done using Siemens SonolineOminia (Germany), with multifrequency probe (3.5-5.0 Mhz) and/or high frequency linear probe (7.5 – 9.0 Mhz) and Siemens Sonoline G50 (Germany), with convex

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probe (3.5-5.0Mhz) and/or high frequency linear probe (7.5 – 10.0 Mhz). MRI was done on Siemens Magnetom Vision MRI (Germany) of 1.5 T. The findings were recorded. FNAC was done andmaterial was sent for cytopathological examination.

To ensure distension of gall bladder a fasting of 6 hours was ensured. For ultrasonography, both supine and right anterior oblique views were obtained as some patients have livers tucked beneath the lower right ribs. Suspended inspiration enables examination of the dome of the liver frequently an ultrasound blind spot. Doppler ultrasound was used for the assessment of blood vessels. To look for lower end of common bile duct patient was asked to drink about 200 ml of water to fill the stomach (water filled technique) as it provided good ultrasound window. This was done in patients with suspected distal extrahepatic obstruction. Ultrasonography of whole abdomen was done to assess other findings related to disease e.g; regional lymph node involvement, ascitis or primary lesion.

Hepatic MRI was performed using phased array body coils with the patient in supine position. T1 and T2 weighted images were taken in axial and coronal planes. For T1 weighted images Multislice gradient echo (GRE) sequences were taken. T2 weighted images were obtained using turbo spin echo sequences. MRCP was done as per requirement, using heavily T2 weighted sequence. Intravenous contrast agents were used, if needed.

Results

In this study, patients were in the age range of 24 to 71 years with maximum number of patients in the age group of 51 to 60 years followed by age group of 41 to 50 years. There were 23 (54%) males and 19 (46%) females in this study.

The most common complaint was right upper quadrant pain noted in 36 cases (86%). Jaundice was next common symptom seen in 16 cases (38%). Lump in right hypochondrium was noted in 12 patients (29%) and itch was complaint in only 5 patients.

The positive findings were seen on ultrasound of all the 42 cases.Majority of malignant lesions had enlarged liver with heterogenousechopattern. Majority of the malignant lesions were multiple and hyperechoic (Fig.-1). The biliary radicles were normal in most of them with dilatation and distortion in few of them mainly in CBD masses (Fig.-2). Portal vein was normal in most of them with presence of thrombus in one of the lesions(Fig.-3). The location was mostly lobar and the margins were irregular in most of them. The masses were vascular in 76% cases. Tables -1a, 1b, 1c & 1d show the various findings on ultrasonography in liver, gall bladder, CBD and other associated abdominal findings respectively.

Table- 1(a) -Findings of ultrasound in liver masses (total cases=42)

US. Features	Primary HCC	Adeno Carcinoma	Poorly DifferenCa	Met. Deposits	Focal Nodular Hyper	Others*
Size	1En	7 En,2Nor	7 Enlar, 4nor	1 Nor	1 enlarged	10 nor, 8enlar
Echopattern	1heter	7 Homo 2 Hetero	9 hetero,1homo,1iso	1 Hetero	1 Homo	14 hetero,4homo
Echogenicity	1hypo	4 Iso,3Hypo 2 hyper	9hyper, 1 iso,1 hypo	1 Iso	1 Hypo	6 hyper,4 hypo,8iso
Number of lesions	1Multi.	6 Multi 3 Sol	4 sol,7Multi	Multi	Sol	16 multi,2 Sol
Billiary radicles	1Nor	6 nor,3dil	3 dil,8Nor	Normal	1 Dil	2 Dil,16 Nor
Portal Vein	1Nor	9Nor	1 Thrombus, 10 Nor	Normal	Nor	18 Nor
Hepatic Vein	1Nor	9Nor	11 Nor	Normal	Nor	1 comp,17 nor
Shape	1Reg	4 ill def,5 well def	8 well def, 3ill def	1 well def	1 well def	12 ill def,6 well def
Location	1lobar	7 lobar,2seg	7 lobar,4seg	Bilobar	1 Seg	11 lobar,7seg
Margins	1Reg	5 irr,4reg	5 Irr,6reg	1irr	1 Reg	17 irr, 1reg

*Others-Patients in whom FNAC was not possible due to altered coagulation profile.

Table – 1(b) - Findings in Gall Bladder (Total cases=42)

Finding	Number	Percentage
Mass	17	41%
Calculi	15	36%
Irregular wall	5	12%
Regular wall	5	12%
Cholecystectomy status	1	3%
Normal	16	38%

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On MRI the size was enlarged in majority of malignant lesions with heterogenous signal intensity and dilatation of the biliary radicles (Fig.-4). The portal vein and hepatic vessels were not visualized in one of them. The lesions were mostly single with ill-defined margins and the location was mostly lobar. The gall bladder showed mass in 41% patients with presence of calculi in 46% patients. The CBD showed mass in 14% patients with presence of calculi in 5% patients(Fig.-5. Fig.-6).

Table- 1(c)- Findings in CBD (Total cases=42):

Findings	Number	Percentage
Mass	2	5%
Calculi	1	3%
Dilated	2	5%
Compressed	1	3%
Displaced	1	3%
Normal	35	83%

Table- 1(d)- Associated findings in abdomen (Total cases=42)

Findings	Number	Percentage
Portahepatis	7 lymphadenopathy	17%
Retroperitoneum	11 lymphadenopathy	26%
Free fluid	8	19%
Color Doppler	Avascular: 10 Vascular: 32	24% 76%

Ultrasound and MRI demonstrated a varied type of liver masses. Among these liver masses FNAC was done in patients who had a normal coagulation profile(Fig.-7). Out of those diagnosed as having liver masses, only 4% was benign while others were malignant. Out of the malignant 52% were poorly differentiated carcinoma, 36% were adenocarcinoma while 4% were Hepatocellular carcinoma and 4% metastatic deposits(Fig.-8, Fig.-9 & Fig.-10) (Table -2).

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Table- 2- (Total cases of FNAC - 23)

Pathology	Number	Percentage
Poorly differentiated carcinoma	12	52%
Adenocarcinoma	8	36%
Metastatic deposits	1	4%
Hepatocellular carcinoma	1	4%
Focal nodular hyperplasia	1	4%

In 34% of cases mass was seen in the gall bladder while in only 7% mass was seen in the CBD. Ultrasound detected 2 out of three CBD masses i.e.67% while MRI detected all the 100% cases. Mass in the liver was seen in 79% of the cases. In 39% of metastasis halo sign was seen while in 31% the lesions were hypoechoic. The lesions were hyperechoic in 23% cases while in only 7% they were isoechoic.

On Ultrasound imaging 27 lesions (64%) should have been malignant and 15 cases (36%) should have been benign. On MRI 17 cases (77%) should have been malignant and 5 cases (23%) should have been benign. But FNAC was done in 23 cases only who had a normal coagulation profile. Out of these 23 malignancy was proved in 22 cases (96%). Thus MRI and Ultrasound have almost equivalent results in hepatic and gall bladder masses while significant difference was seen in diagnosing cholangiocarcinoma.

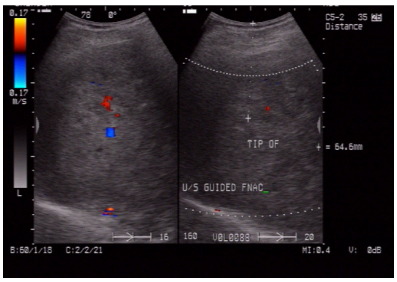

Fig.-1 – Hyperechoic SOL in liver parenchyma with vascularity within.

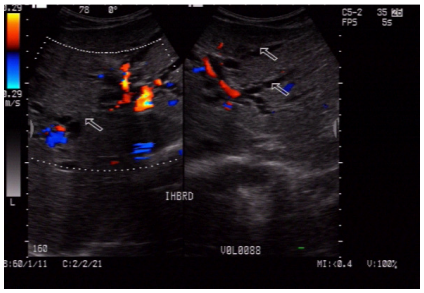

Fig.-2 – Ultrasound image of a patient showing IHBRDs (arrows)

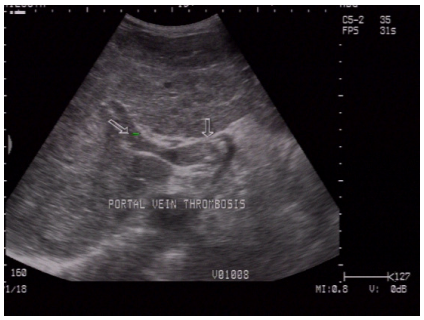

Fig.-3 - Portal vein thrombosis (arrows)

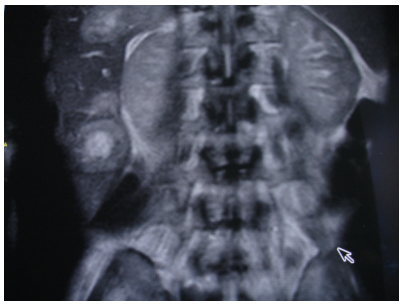

Fig.-4 – Coronal T2W MRI- liver metastases showing heterogeneous signal intensity with central hyperintense and peripheral isointense areas.

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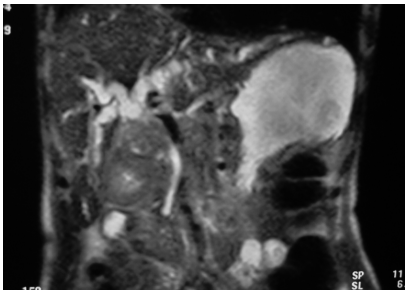

Fig.-5 – T2 weighted coronal MR image showing mass in gall bladder and CBD with IHBRD

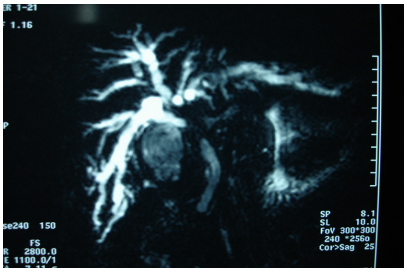

Fig.-6 – MRCP image showing IHBRD

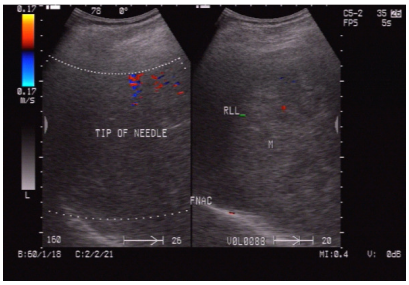

Fig.-7– Ultrasound showing FNAC of hyperechoic SOL with irregular margins in right lobe of liver.

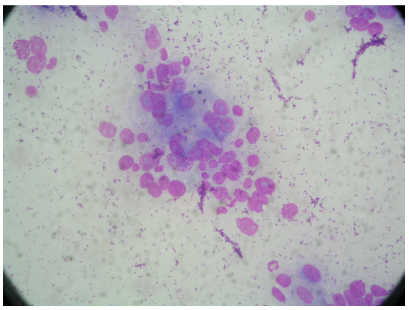

Fig.-8 – Hepatocellular carcinoma (cytology) showing prominent nucleoli and mitotic figure.

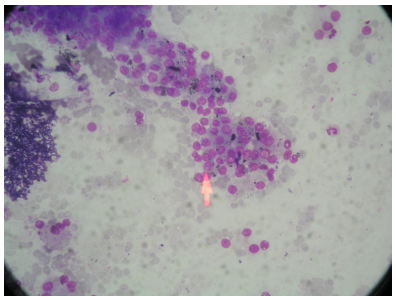

Fig.9 – Primary (HCC): Intranuclear cytoplasmic inclusion

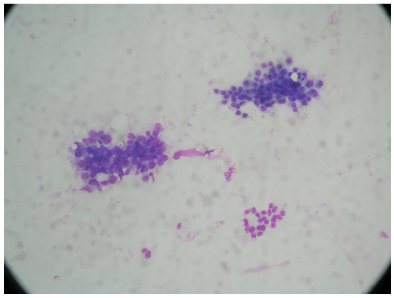

Fig.-10– Secondary : Poorly differentiated carcinoma

Discussion

This study consists of 42 datasets among which Ultrasonography has been done in all of them and MRI in 22 patients was done who met the inclusion criteria followed by Fine needle aspiration cytology (FNAC) of 23 patients. Szklaruk J, Silverman PM and Charnsangavej C stated that Hepatocellular carcinoma is one of the most common malignancies worldwide accounting for 6% of all the malignancies. The peak age of incidence is 50-70 years with a male predominance of 4:1 (4). In the present series, maximum number of patients were in the age group of 51 to 60 years followed by age group of 41 to 50 years Thus majority of patients (62%) were in the fifth and sixth decade of their life.Rummeny E, Saini S, Wittenberg J, Compton C found that malignant hepatic lesions show morphologic features that distinguish them from benign masses. These include lesion inhomogeneity,

central liquifactive necrosis, unsharp outer margins and peritumouraloedema. Occasionally metastasis may appear hyperintense and mimic haemangioma(5).

Hussain SM, Terkivatan T, Zondervan PE et al said that Focal nodular hyperplasia is the second most common benign tumour after haemangioma. MRI has higher sensitivity and specificity for Focal nodular hyperplasia. On ultrasonography there is presence of vascular lesion with central feeding artery (6).

Levy AD, Murakata LA, Rohrman CA et al. studied that adverse spectrum of tumour and tumour like lesions arise from the gall bladder and bile ducts. In the clinical settings of patients with nonspecific abdominal complaints or symptoms of biliary obstruction, the discovery of bile duct polyp, gall bladder wall thickening or biliary stricture is most often indicative of malignancy. However, the differential diagnosis should include benign tumour and tumour like lesions (7).In the present study also patients with non-specific abdominal complaints as pain or jaundice or itch were diagnosed on imaging as having gall bladder mass, CBD mass or a liver mass, which was proved malignant on FNAC.

RooholaminiSA, Tehrani NS, Razavi MK et al found that carcinoma of gall bladder is most common malignant tumour of biliary tract. Clinical manifestation includes right upper quadrant pain, anorexia, weight loss and jaundice. Associated findings were cholelithiasis (64%). Histologic diagnosis were (90%) adenocarcinoma and squamous cell carcinoma (10%) (8).Pandey M., Sood BP, Shukla RC et al. found Sonography to be good diagnostic tool for carcinoma of the gall bladder. A mass in the gall bladder and gall bladder wall thickening (>12mm) were cardinal sonographic findings of carcinoma. Sonography was highly accurate for detecting mass lesions, gallstones, liver infiltration, metastasis and ascitis. However visualization of lymph nodes, CBD infiltration and peritoneal dissemination was poor (9). In the present study also ultrasound detected mass lesions, gallstones, liver infiltration, metastasis and ascitis. Lymph node spread and CBD infiltration were better delineated with MRI and MRCP respectively.

In 77% cases MRI showed malignancy while on ultrasound it was only 64%. On FNAC 96% of the lesions were malignant . In cholan-giocarcinomas ultrasound was able to demonstrate mass in only 2 out of three i.e. 67% cases. While MRI demonstrated all the three i.e.100% cases. Thus as compared to ultrasound MRI is a multiplanar imaging and provides 3D imaging of the liver for detection, diagnosis and spread of tumour. MRCP is further helpful in diagnosing cause of biliary obstruction i.e. malignant or calculus. It is helpful in evaluation of biliary tree prestenosis as well as poststenosis. As a result of major advancements in field gradient technology and multichannel surface coils, magnetic resonance (MR) imaging is playing an increasingly greater role in the accurate, noninvasive detection and charac-terization of hepatic lesions. Because of its relatively lower cost, shorter acquisition times, and wider availability, computed tomography (CT) has long been the traditional mainstay for clinical hepatic imaging. However, because MR imaging displays the same lesion contrast enhancement patterns as CT, but with superior

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lesion-to-liver contrast and without the use of ionizing radiation, there has been increasing interest in and experience with MR imaging in this regard. In addition, the use of newer pulse sequences, along with hepatocyte-specific contrast agents (eg, gadobenatedimeglumine [Gd-BOPTA {benzyloxypropionictetraacetate}], may facilitate a more specific diagnosis of the lesion in question(10).

Conclusion

As compared to ultrasound MRI is a multiplanar imaging and provides 3D imaging of the liver for detection, diagnosis and spread of tumour. MRCP is further helpful in diagnosing cause of biliary obstruction i.e. malignant or calculus. It is helpful in evaluation of biliary tree prestenosis as well as poststenosis. Role of MR imaging for clinical hepatobiliary imaging continues to evolve with newer pulse sequences and contrast agents.

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