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Role of MRI in Differentiation of Focal Liver Lesions

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Abstract: ***Introduction: The increasing and widespread use of imaging studies has led to an increase in detection of incidental Focal Liver Lesions. It is important to diagnose not only malignant liver lesions, but also benign solid and cystic liver lesions. The non-invasive diagnosis of liver lesions is usually achieved with contrast material-enhanced computed tomography and Magnetic Resonance (MR) imaging. Dynamic three dimensional gradient-recalled-echo MR imaging provides dynamic contrast-enhanced thin-section images with fat saturation and a high signal-to-noise ratio and is excellent for the evaluation of various focal hepatic lesions. Objectives: Role of MRI imaging in characterization and differentiation of various focal liver lesions detected incidentally on Ultrasonography. Methods: This was a multicentric/single center study conducted on In patients and Outpatients of Pandit Deendayal Upadhyay Medical College and Hospital, Rajkot. The present study included 50 patients with various focal Liver Lesions detected incidentally on Ultrasonography. MRI Liver of the patients having incidentally detected Focal Liver Lesions on Ultrasonography and Inconclusive Ultrasonography findings was done to characterize the various focal liver lesions. Pathological and post-operative histopathological findings were noted. Microsoft excel software was used for data analysis and tables were prepared for comparison of collected data. Result: Of the 50 patients, 30 patients were male and 20 were female. Age of patients ranged from 5 year to 78 years. Spectrum of diseases based on imaging findings includes: Hepatic cyst (5/50, 10%), Hemangiomas (7/50, 14%), Focal nodular hyperplasia (2/50, 4%), Hydatid cyst (2/50, 4%), abscess (2/50, 4%), hepatocellular carcinoma (11/50, 22%), metastases (9/50, 18%) and others (12/50, 24%). Metastasis and Hepatocellular Carcinoma (HCC) were most common malignant lesions in liver while Hemangiomas were most common benign lesions followed by simple and complex cysts and hepatic adenoma. Conclusion: MRI has an excellent lesion detection rate. Nearly all the lesions detected on Ultrasonography were detected on MRI imaging. MRI is excellent for the characterization and differentiation of various Focal Liver Lesions. It was possible to reach to a specific radiological diagnosis in most of the patients.***

Keywords: MRI, Focal liver lesions, histopatholgy, benign, malignant

1. Introduction

Focal liver lesions constitute a daily challenge in the clinical setting. Accurate detection and characterization of liver lesions is paramount for appropriate treatment in a wide variety of clinical settings. Focal liver disease is a common diagnostic problem referred to radiologists for evaluation owing to its non-specific clinical presentation and marked inter-observer variation on clinical examination. Focal hepatic lesions include a large gamut of both benign and malignant lesions such as hepatic cysts, liver abscesses, hemangioma, adenoma, focal nodular hyperplasia, hepatocellular carcinoma, hepatoblastoma, metastases etc. Modern operative techniques and local therapies such as Radiofrequency (RF) ablation are effective methods to treat liver metastases or primary hepatic malignancies. Therefore, the determination of liver lesion count, and the nature of the lesion are important. The optimal imaging modality for the detection of focal liver lesions has been robustly debated over the past two decades. Imaging modalities currently available to specifically evaluate focal liver disease include transabdominal and intraoperative ultrasound, triphasic Computed Tomography (CT), Computed Tomographic Arterial Portography (CTAP), and MRI enhanced with one or more types of contrast agent. These are often complementary, and various combinations may be appropriate in different clinical settings.

Non-invasive methods can be useful in the detection and characterization of these lesions, usually achieved with contrast material-enhanced computed tomography and Magnetic Resonance (MR) imaging. Dynamic three-dimensional gradient-recalled echoes MR imaging is a widely available non-invasive method of complete liver evaluation which provides dynamic contrast-enhanced thin-section images with fat saturation and a high signal-to-noise ratio. This is due to the high intrinsic soft-tissue contrast, improved biochemical and anatomic information, sensitivity to perfusion differences, multiplanar capability, and lack of ionizing radiation that MRI has surpassed all other liver imaging modalities [1]. It is the most sensitive and specific modality to show the focal liver lesions in a normal liver [1, 2]. Its high intrinsic contrast allows the detection of small

lesions, while the characteristics of the signal intensity on T1- and T2-weighted images allows the characterization of each lesion, with very high specificity in differentiating benign from malignant lesions.

Dynamic gadolinium-enhanced magnetic resonance imaging, as part of a comprehensive liver MRI protocol, has emerged as an important tool for liver lesion detection and characterization, providing accurate diagnostic information without the use of ionizing radiation. Detection, characterization, enumeration, and localisation of primary or metastatic hepatic neoplasms is critical for planning appropriate therapy. [3]. The use of three-dimensional (3D) gradient-recalled-echo (GRE) sequences such as volumetric interpolated breath-hold examination (VIBE) has improved MR imaging by providing dynamic contrast material-enhanced thin-section images with fat saturation and a high signal-to-noise ratio [4]. Contrast-enhanced 3D GRE MR imaging demonstrates characteristic enhancement patterns that can be helpful in the diagnosis of various focal hepatic lesions. These enhancement patterns are seen during specific phases of imaging and include arterial phase enhancement, delayed phase enhancement, peripheral washout, ring enhancement, nodule-within-a-nodule enhancement, true central scar, pseudo central scar, and pseudo-capsule. Magnetic resonance (MR) imaging findings of focal liver lesions depend on their histological and cytological features. Careful assessment of the enhancement properties of dynamic images obtained before and after administration of Intravenous Contrast Material (IVCM) is valuable in the characterization of the mass [5]. Familiarity with these enhancement patterns can help in the identification of specific focal lesions of the liver.

Hence, the aim of the present study was evaluation of MRI features of Focal liver lesions.

2. Materials and Methods

This was a multicentric/single center study conducted on In patients and Outpatients of Pandit Deendayal Upadhyay Medical College and Hospital, Rajkot.

Inclusion Criteria: Both outpatients and in patients with focal liver lesions diagnosed by Ultrasonography were included in the study after obtaining proper informed consent.

Exclusion Criteria: Patients with general contraindications for MRI, patients with renal failure (GFR<30%) and those patients not willing to give the written consent were excluded from the study.

A total sample of fifty patients was selected for the present study were in the age group of 5 to 78 years with a mean age of 46 years [Table-1]. Clinical features, laboratory tests findings and histopathological findings of the patients were noted for correlation. MRI was done for all the patients.

Table 1: Age distribution of the patients

Age group	Number of patients
1 to 20 years	3
21 to 40 years	13
41 to 60 years	29
>60 years	5

MRI technique: The studies were performed on the 1.5 TESLA MR PLATFORM. A 4-channel phased array TORSO coil was used. Plain and contrast study were done with slice thickness of 7 mm. Plain study was done with using spin echo technique. T1 and T2 sequences were obtained in axial and coronal planes. IN PHASE and OUT OF PHASE imaging was done wherever required. Dynamic contrast enhanced MRI was done in axial and coronal planes with fat suppression techniques. It was performed after rapid bolus injection (0.1 mmol/kg body weight) of gadolinium dimeglumine. Three dynamics were taken including three minutes equilibrium phase.

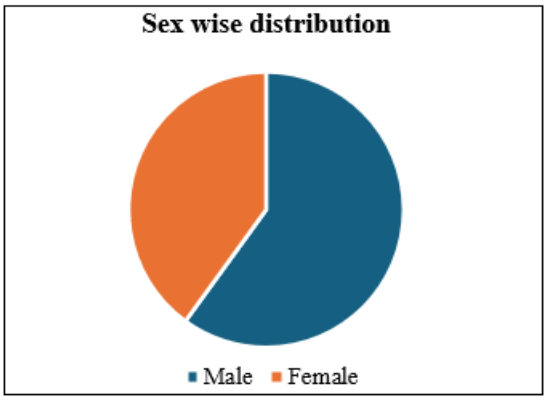
Data Collection and Analysis

Pathological report was noted for correlation and comparison, hence confirmatory for the diagnosis and post-operative histopathological findings of the patients who were operated surgically for liver lesions were noted. The patients who were inoperable or not operated, their FNAC or Tru-cut biopsy findings were noted. Standard proformas were used for individual case for record of data.

Statistical Analysis: Microsoft Excel Software was used to analyze the data. Charts and tables were prepared for representation and comparison of data and sensitivity and specificity for diagnostic accuracy of MRI were calculated.

3. Results

Total 50 patients of varying age group, with 30 males and 20 female patients with male predominance were included in this study.



All patients were referred for MRI with a diagnosis of focal liver lesion on ultrasound. Most common lesions in age group of less than 40 years were benign like hemangiomas, hepatic adenomas and hydatid cyst. Hepatocellular Carcinoma (HCC) was seen in only two patient in this age group. Most common lesions in age group of more than 40 years were malignant like HCC and metastasis. Malignant lesions were common in males like hepatocellular carcinoma, metastasis followed by benign lesions like hemangioma and abscess. Most common lesions in females were benign like hemangiomas, hepatic adenoma and hydatid cyst. One case of hepatoblastoma, and two cases of HCC and cholangiocarcinoma each were seen in females. Metastasis was also seen only in two female patients.

Among 50 patients, 21 (42%) had benign lesions, 25 (50%) had malignant lesions and 4 (8%) had infective lesions. [Table-2]

Table 2: Broad classification of lesions

Nature of lesion	Number of patients	Number of lesions
Benign	21	30 excluding 2 patient with multiple regenerating nodules and hamartoma
Malignant	25	33 excluding 1 patient with multiple metastatic lesions
Infective	4	4

The most common benign lesion was hemangioma in seven patients, most common infective lesion were abscess and hydatid cyst in two patients each and most common malignant lesion was HCC in eleven patients. Most common lobe involved in patients is right lobe in 30 (60%) patients followed by involvement of both lobes in 14 (28%) patients and left lobe in 6 (12%) patients.

Malignant Lesions:

Hepatocellular carcinoma (HCC): This study involved eleven patients of Hepatocellular carcinoma, and nine were seen in males while two cases were seen in female. All the lesions were solitary in nature. Nine lesions were in right lobe, two were in left lobe, all were heterogeneously hypoechoic on ultrasound and eight lesions (73%) were hypointense on T1 . Three lesions (27%) were heterogeneously hyperintense on T1 due to hemorrhage in the lesions while all the lesions were heterogeneously hyperintense on T2 weighted images. One lesion showed persistent heterogenous enhancement in all phase with enhancing septae and no washout in portal or equilibrium phase. This lesion was characterized as Metastasis on MRI which turned out to be a Hypo vascular hepatocellular carcinoma. [Fig-1 and 2]

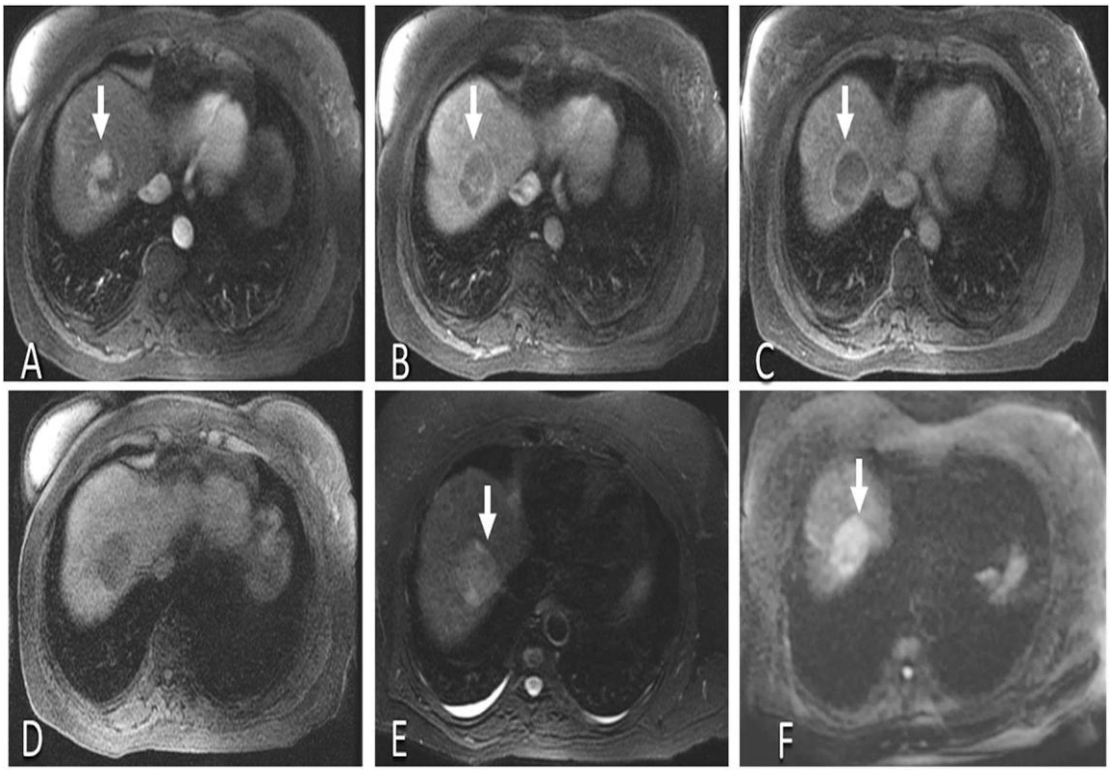


Figure 1: Axial magnetic resonance imaging of the HCC in a 57-year-old patient with cirrhosis secondary to chronic hepatitis C infection. Arterial (A), portal venous (B), delayed (C) phase demonstrating arterial phase hyperenhancement in HCC (arrow) which washes out on portal venous and delayed phases. This mass demonstrates T1 hypointensity (D), and mild T2 hyperintensity (E) with mild restricted diffusion (F).

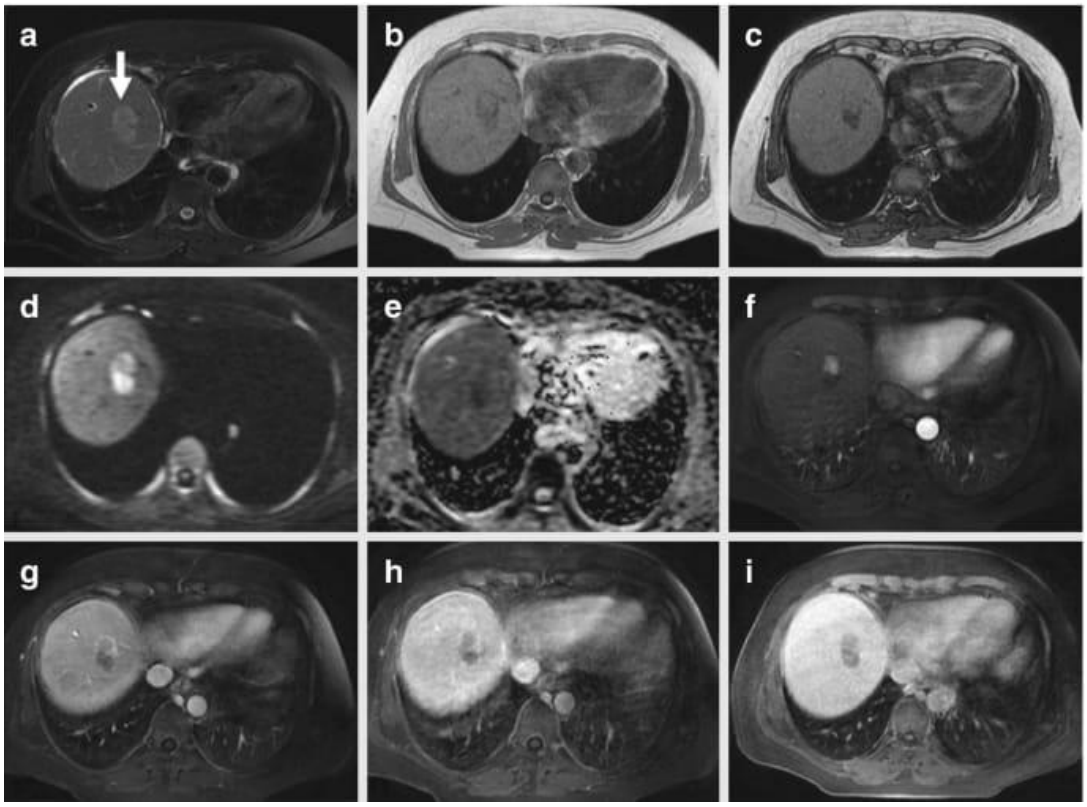


Figure 2: (a–c) A 3-cm nodule is appreciable on segment 8 (white arrow), mildly hyperintense on axial T2-weighted fat saturated (a), partially hyperintense on T1-weighted in-phase gradient echo (GRE) (b) with a partial signal drop-out on axial out-of-phase GRE (c) as expression intralesional fat. (d, e) Diffusion-weighted imaging (d), and apparent diffusion coefficient map (e) show lesion restriction related to hypercellularity. (f–i) Axial T1-weighted fat-saturated sequence in the arterial phase shows intense arterial wash-in of the upper portion of the nodule (f), with wash-out in the portal venous (g) and delayed (h) phases and lack of contrast agent uptake in the hepatobiliary phase (i).

Metastasis: This study included eight patients (total 19 lesions) excluding one patient with multiple lesions of metastasis, all in the age group of 40-60 years. There were known primary malignancies in the seven patients as hepatocellular carcinoma, carcinoma rectum, jejunal malignancy, carcinoma pancreas and Gastrointestinal Stromal Tumor (GIST) involving the duodenum. All the lesions were hypoechoic on ultrasound. Eighteen lesions out of nineteen were hypointense on T1. One lesion showed mild heterogenous enhancement with washout in portal and equilibrium phase. lesion was characterised as Hepatocellular carcinoma which turned out to be metastasis from unknown primary [Fig-3 and 4].

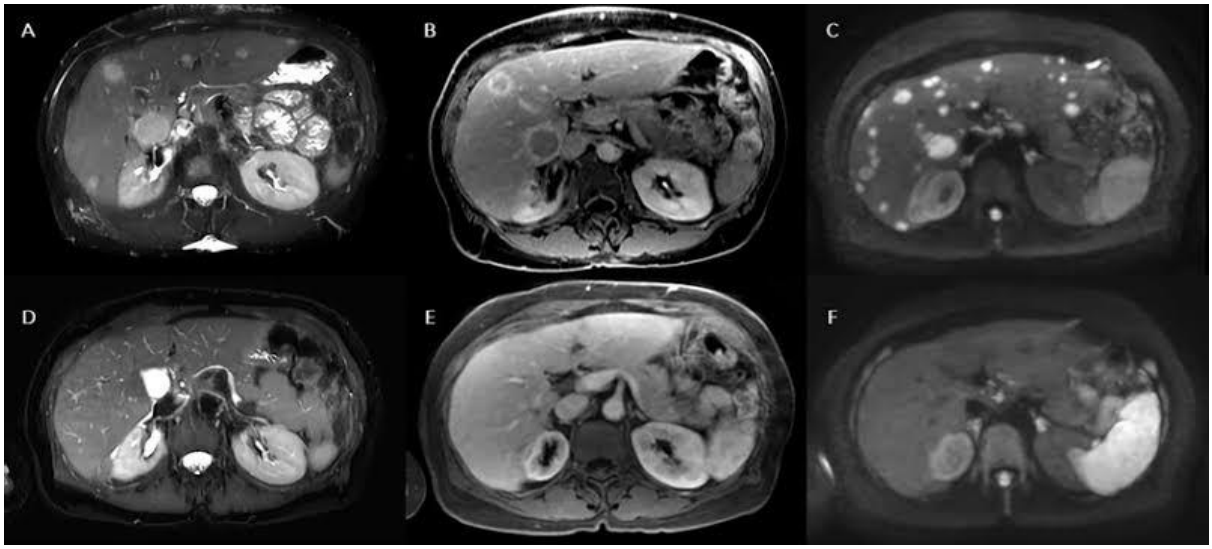


Figure 3: Liver metastases at MRI exam. Axial plane images showing multiples liver metastasis in both hepatic lobes (upper images) at T2 fat-sat (A and D), portal-phase post-contrast T1 fat-sat (B and E) and diffusion-weighted images (C and F).

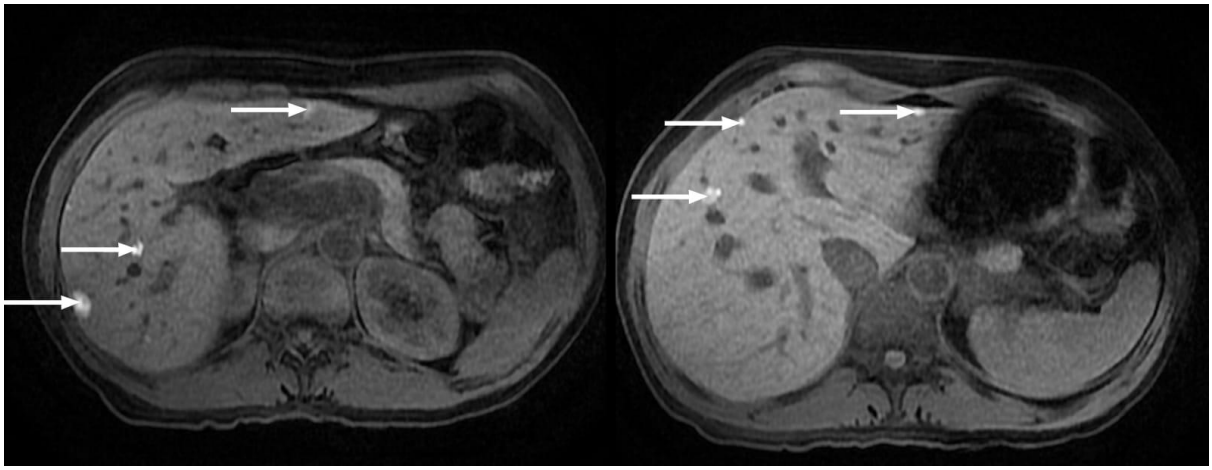


Figure 4: Multiple liver metastases from melanoma. Hepatic metastases showing a characteristic high signal on fat saturated T1-weighted imaging due to their melanocytic content (arrows).

Cholangiocarcinoma: Two lesions of cholangiocarcinoma was accurately characterized while one lesion was diagnosed as HCC on MRI which turned out to be cholangiocarcinoma after biopsy report. Early peripheral Post contrast enhancement with progressive centripetal enhancement was seen [Fig-5].

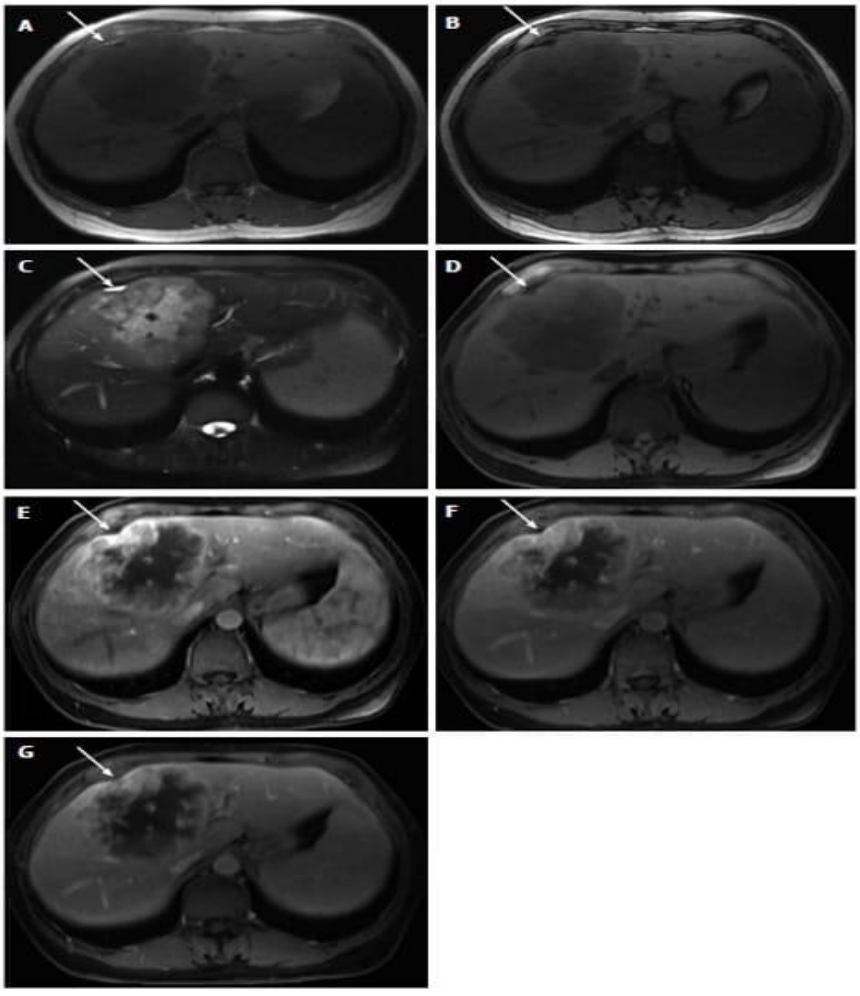


Figure 5: Intrahepatic cholangiocarcinoma. In- (A) and opposed-phase (B) GRE T1-WI, fat-suppressed FSE T2-WI (C), pre (D) and postcontrast fat-suppressed 3D-GRE T1-WI at the arterial (E), portal venous (F) and interstitial (G) phases. The tumor shows low signal intensity on T1-WI (A, B and D), high signal intensity on T2-WI (C), and heterogeneous peripheral continuous and progressive enhancement on post-gadolinium images (E-G). Associated capsular retraction is also noted (white arrow, A-G). GRE: Gradient-echo; FSE: Fast spin echo; T1-WI: T1-weighted images

Hepatoblastoma: One lesion of Hepatoblastoma was not characterized due to the imaging features like Giant hemangioma, while one lesion was accurately diagnosed. The lesion showed heterogenous mixed intensity on T1 and T2 with patchy enhancement in arterial phase and progressive filling in portal and equilibrium phase [Fig-6]

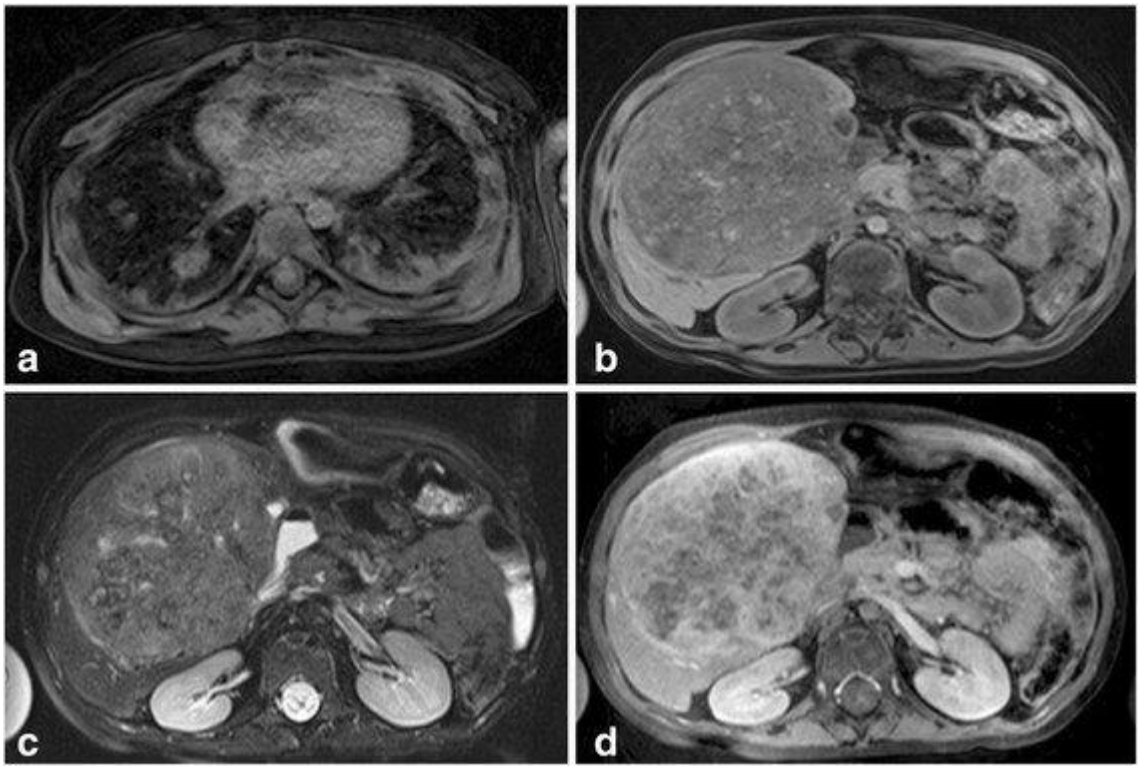
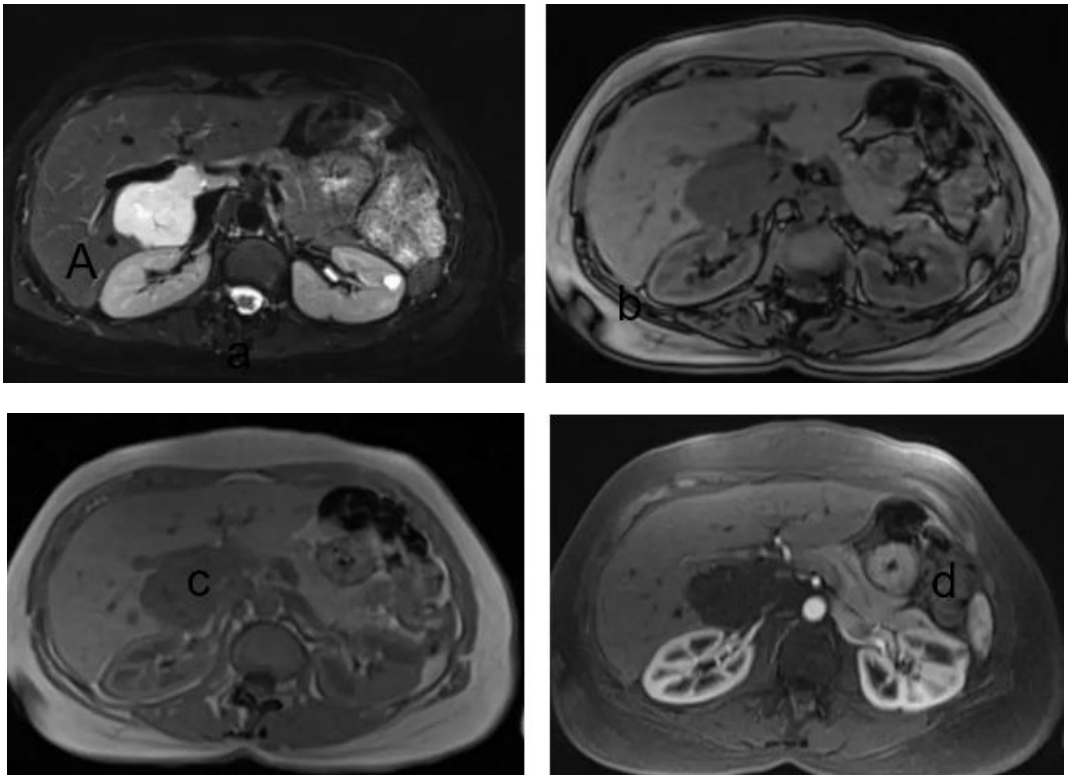


Figure 6: Hepatoblastoma in a 5-year-old patient. The (a) axial T1-weighted fat saturated imaging of the lung bases demonstrates multiple pulmonary metastases. On (b) T1-weighted fat-saturated pre-contrast imaging, the hepatic mass has internal heterogenous signal intensity, with overall hypointensity compared to background liver parenchyma. It is mildly hyperintense compared to the liver parenchyma on (c) the T2-weighted fat saturated sequence. On (d) portal venous phase imaging, post contrast administration, the lesion has internal heterogeneous enhancement

Benign Lesions:

Hemangioma: The study included seven patients with haemangiomas and sixteen lesions were studied in them. Among five lesions of giant hemangioma, four lesions were heterogeneously hyperechoic on ultrasound and one lesion was heterogeneously hypoechoic. Rest all the small hemangioma, were hyperechoic on ultrasound. All the lesions were Hypointense on T1 weighted images. All the lesions showed typical peripheral nodular enhancement and progressive centripetal filling [Fig-7]



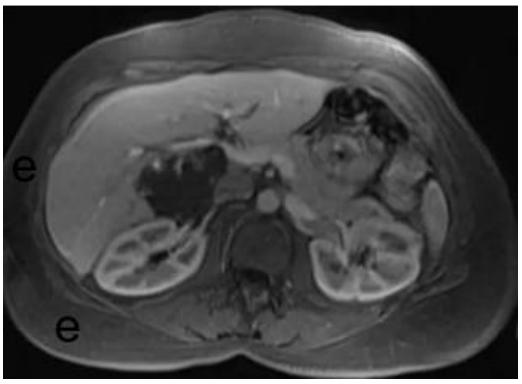


Figure 7: a) T2 fat saturated axial hemangioma b) T1 in phase c) T1 out of phase d) T1 post contrast arterial phase e) T1 post contrast venous phase

Cyst: Characteristic feature being homogenous T2 hyperintensity and no enhancement. Complex cysts had septations within.

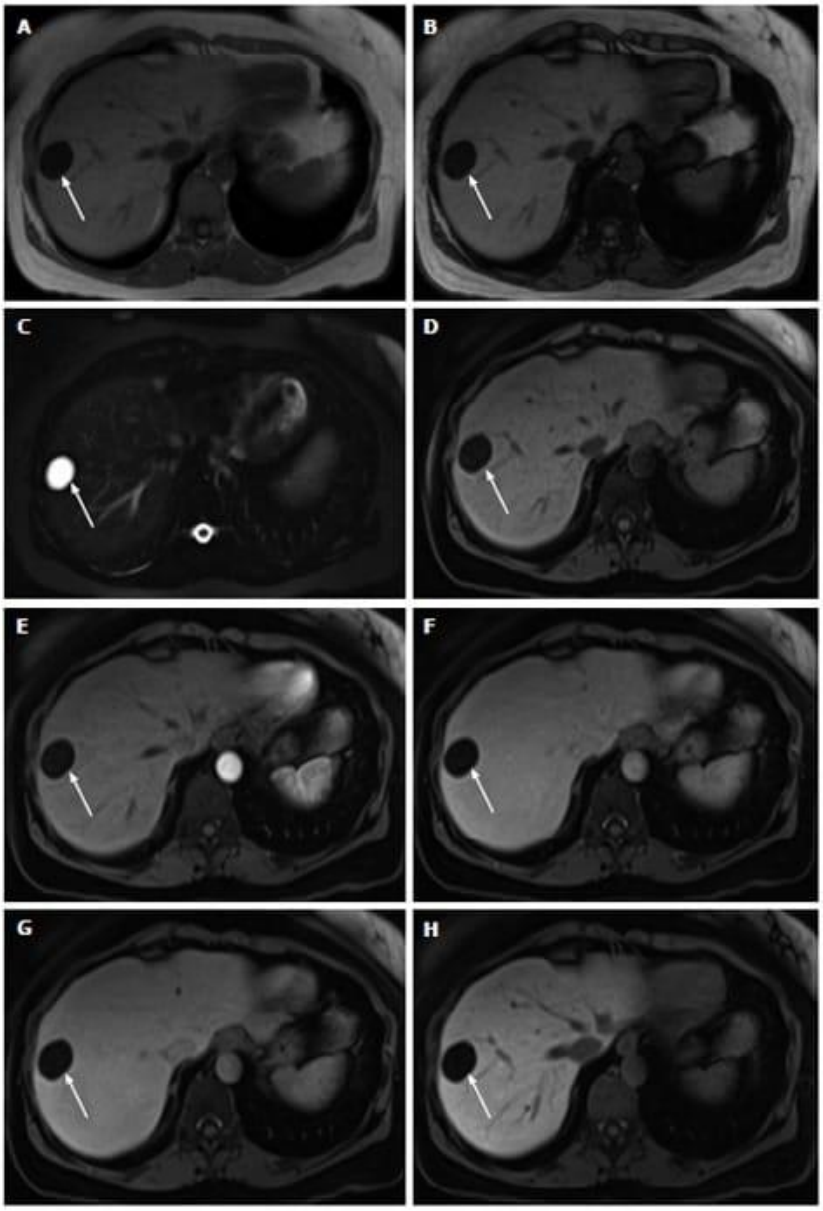


Figure 8: Cyst. In- (A) and opposed-phase (B) GRE T1-WI, fat-suppressed FSE T2-WI (C), pre (D) and post hepatocyte-specific contrast agent fat-suppressed 3D-GRE T1-WI at the arterial (E), portal venous (F), interstitial (G) and hepatobiliary (H) phases. There is a well-defined lesion on the right hepatic lobe (arrow, A-H) showing marked homogeneous low signal intensity on T1-WI (A, B and D), homogeneous very high signal intensity on T2-WI (C) and no enhancement after gadolinium administration (E-H), consistent with simple liver cyst. GRE: Gradient-echo; FSE: Fast spin echo; T1-WI: T1-weighted images.

Multiple biliary hamartomas (MBH) are a rare cause of multiple benign hepatic lesions. The condition is also known as von Meyenburg complexes, multiple bile duct hamartomas, or biliary micro-hamartomas. Multiple biliary hamartomas are asymptomatic and usually found incidentally. [Fig-9]

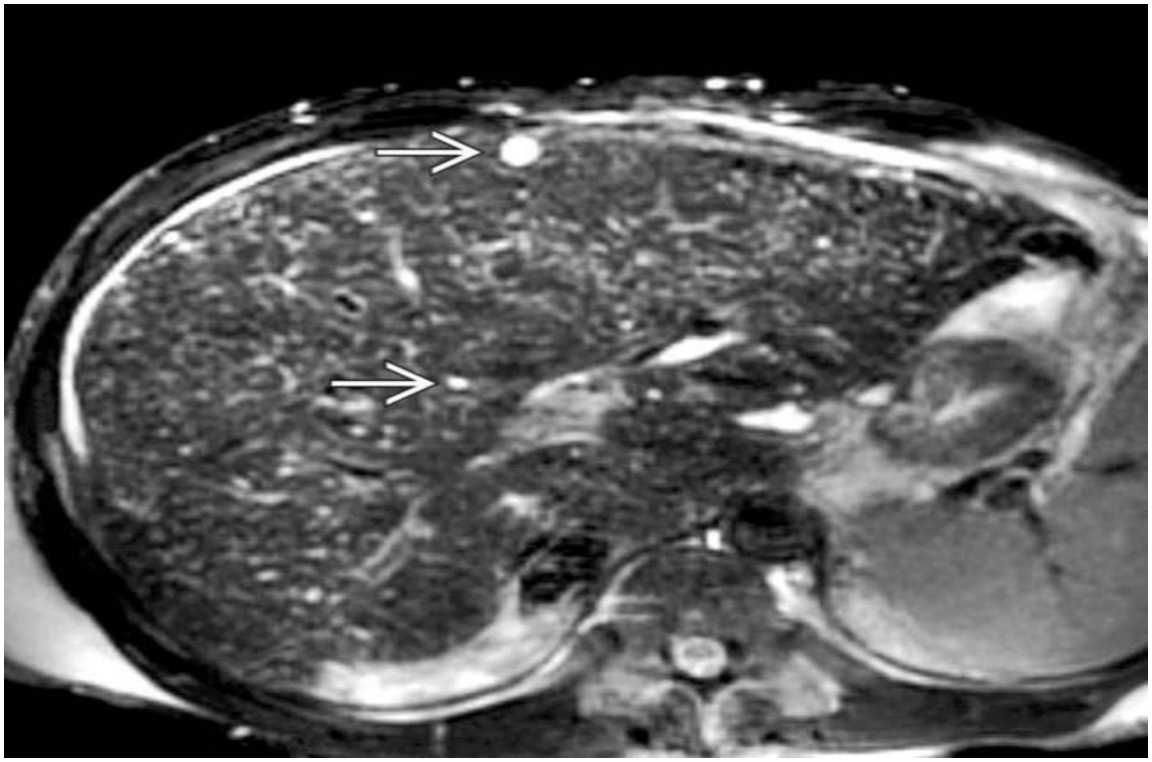


Figure 9: Axial T2WI MR shows innumerable tiny bright foci throughout the liver image, representing biliary hamartomas. This patient also had evidence of congenital hepatic fibrosis on imaging and liver biopsy, both part of the congenital hepatic and renal fibro polycystic disease spectrum.

Hepatic adenoma: The study included four patients with hepatic adenomas, and three of them were females in the age group of 20-40 years while one was male, total of five lesions with average size of the lesions being 5.3 cms. These patients with imaging features of well-defined homogenous lesion with fat component within, showing signal drop in OUT OF PHASE images and mild enhancement on arterial phase with washout in subsequent phases were accurately characterized as hepatic adenoma. [Fig-10]

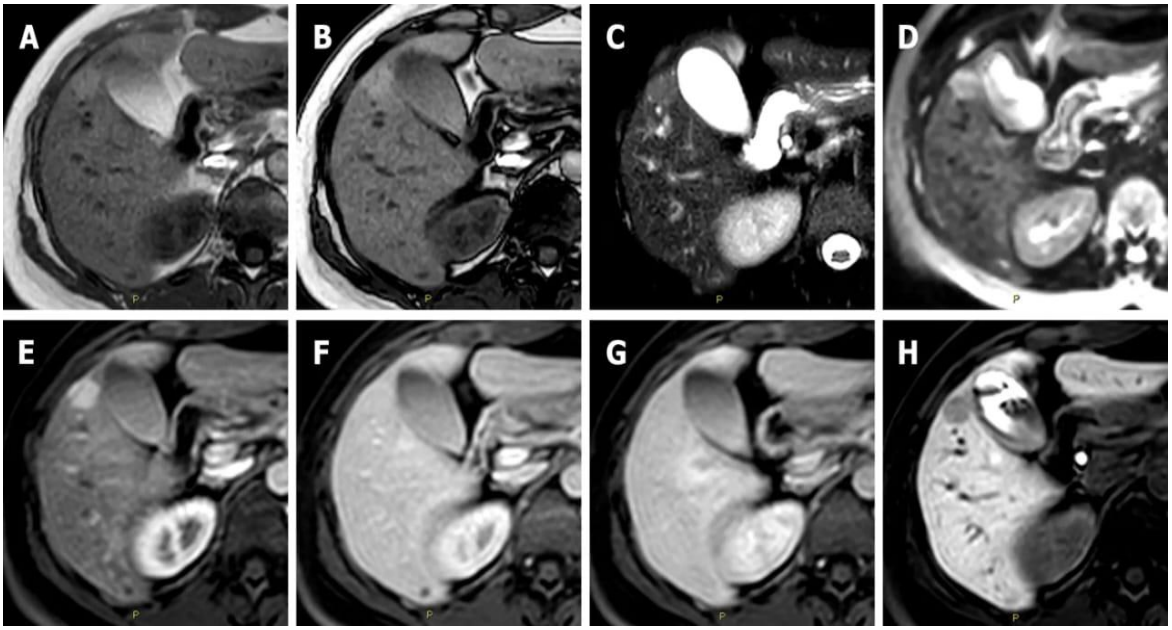


Figure 10: A: In a 47-year-old woman the axial T1 in-phase; B: Out-of-phase images show an isointense lesion in liver segment V; C: Hyperintense in the T2-weighted; D: In the diffusion-weighted; E: In the arterial phase images; F: Without washout of the contrast media in the portal-venous phase; G: In the delayed phase images; H: Hypointense in the hepatobiliary phase image. [Fig-11]

Focal nodular hyperplasia (FNH): Two lesions of FNH was accurately characterized with distinct feature of homogeneity, central scar which was hyperintense on T2W images which showed delayed enhancement.

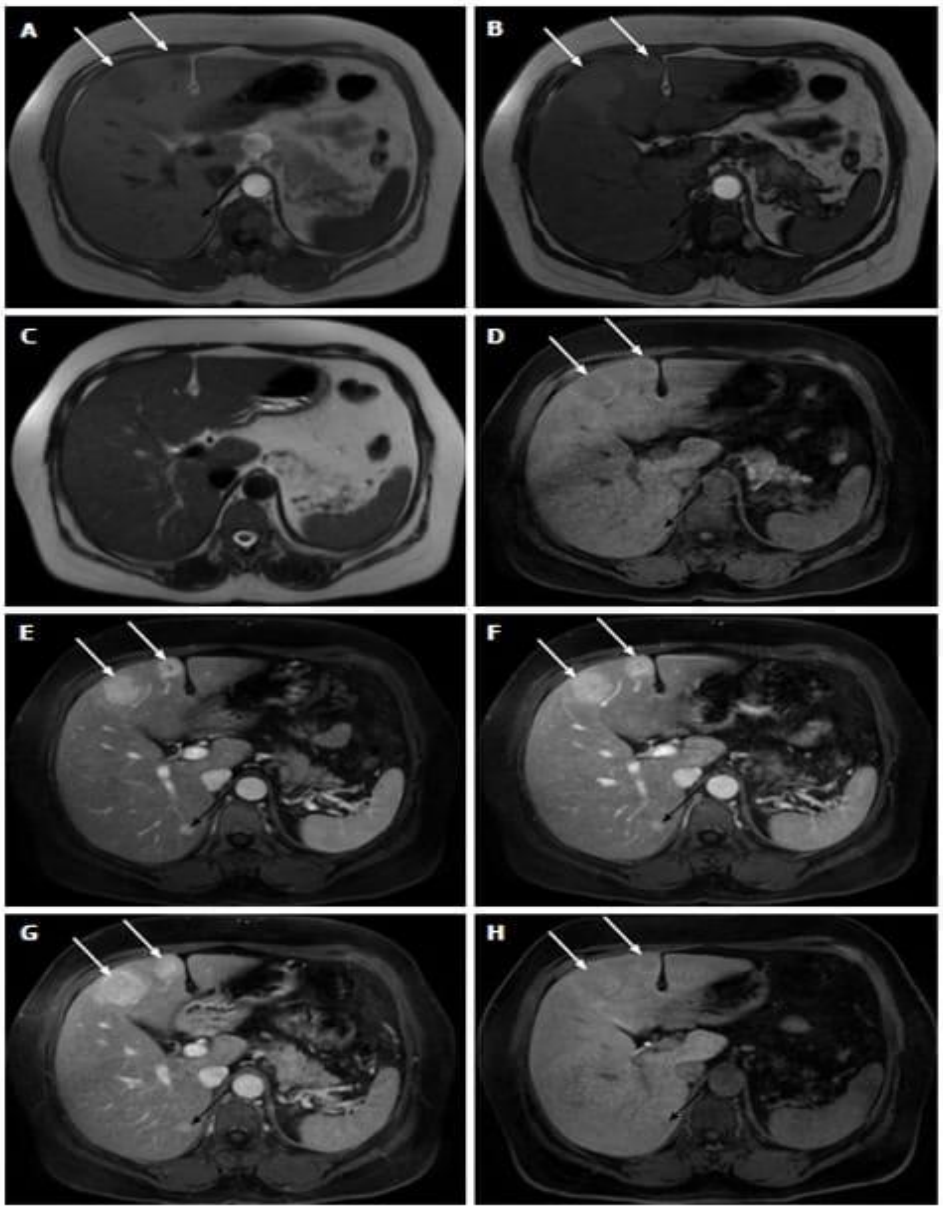


Figure 11: Multiple focal nodular hyperplasia. In- (A) and opposed-phase (B) GRE T1-WI, fat-suppressed FSE T2-WI (C), pre (D) and post hepatocyte-specific contrast agent fat-suppressed 3D-GRE T1-WI at the arterial (E), portal venous (F), interstitial (G) and hepatobiliary (H) phases. There are two focal nodular hyperplasia on the left lobe (white arrows) and one small FNH on the right lobe (black arrow). The liver parenchyma shows drop of signal in the opposed-phase (B) comparing to the in-phase images (A), indicating moderate parenchymal fat deposition. Note that the lesions do not show drop in signal in the opposed-phase (B). All lesions are isointense comparing to the surrounding liver on T2-WI (C), showing uniform blush on the early post-contrast images (E). In this case the lesions enhancement do not fade to iso-intensity on the delayed post-contrast images (F and G) due to the presence of moderate fat deposition in the liver parenchyma. On the hepatobiliary phase, 20 min after the administration the hepatocyte-specific contrast agent, the lesions show uptake of the contrast agent. GRE: Gradient-echo; FSE: Fast spin echo; T1-WI: T1-weighted images.

Regenerating nodules: The study included one patient with multiple regenerating nodules in background of cirrhotic liver. Patient had mildly shrunken liver with surface irregularity and nodularity with presence of ascites, presented as heterogeneously hypoechoic on ultrasound. All of them were hypointense on T1 and T2 weighted images with no post-contrast enhancement. [Fig-12]

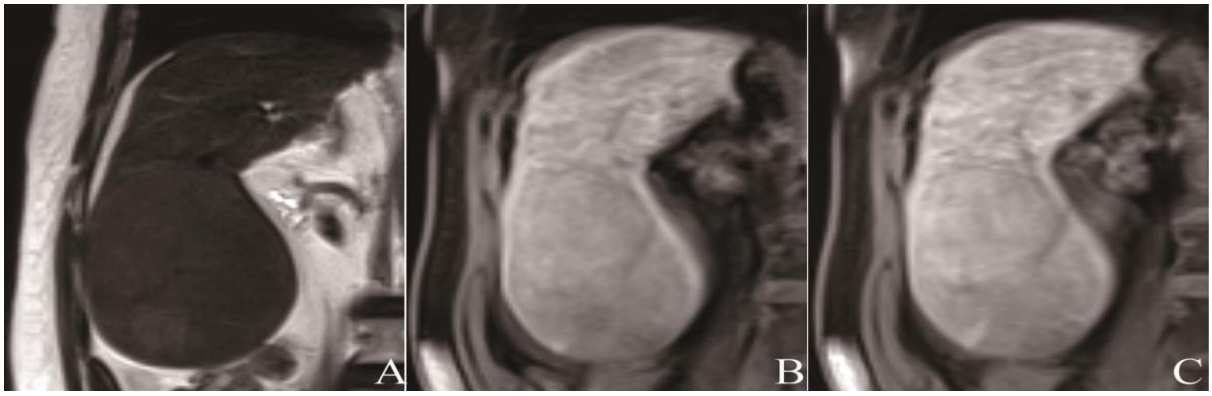


Figure 12: (A) Pre-contrast coronal T2-weighted image shows an oval, well-circumscribed iso-signal mass in segment VI of the liver. (B) Delayed 20 m hepatobiliary phase in the contrast-enhanced MRI shows a slightly hyper enhanced mass and surrounding liver cirrhosis with heterogeneous. (C) Delayed 30 m hepatobiliary phase in the contrast-enhanced MRI shows a persistent slightly hyper enhanced mass.

Hydatid cyst: Distinct features were minimally enhancing T2 low intensity rim and with membranes within. [Fig-13]

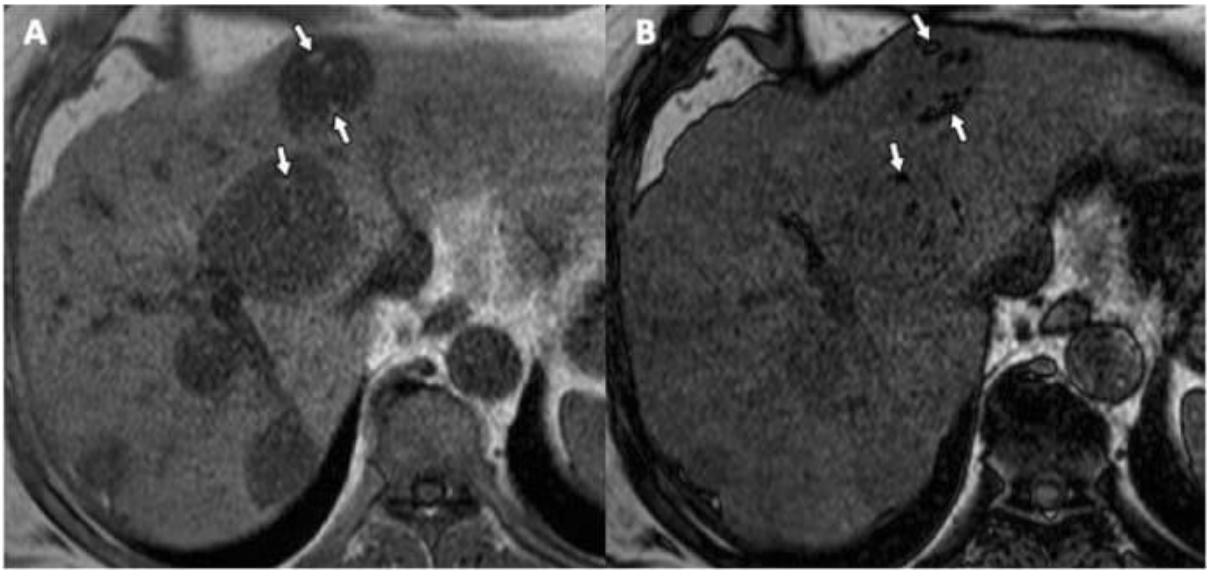


Figure 13: A) Axial gradient-echo in-phase T1-weighted MR image shows multiple high signal intensity foci (arrows) within hepatic hydatid cyst. B) Axial gradient-echo opposed-phase T1-weighted MR image shows macroscopic fat within the same lesions, a finding confirmed by chemical shift artifact and signal cancelation (arrows) surrounding the lipid pure component.

Focal fatty sparing (Pseudo lesion): Focal fatty sparing was accurately characterized in one patient. Lesion had no mass effect. Loss of signal on OUT PHASE T1W images is distinct feature of fat.

4. Discussion

A total of 50 patients referred with a diagnosis of focal liver lesion on ultrasound were included in the present study and underwent conventional MRI (T1, T2, DYNAMIC POST CONTRAST TRIPLE PHASE) and IN PHASE, OUT OF PHASE imaging (wherever applicable) on 1.5 Tesla MRI machine (Signa LXI, GE). Only 35 patients underwent FNA/Biopsy/surgery and histopathology proof was obtained. In remaining 15 patients, there was no histopathological examination done since lesions in all these patients showed typical characteristic features on MRI and hence no further diagnostic work-up was needed. Trastek VF et al., in their study concluded that Fine-needle aspiration (FNA) should be avoided if benign lesion like hemangioma remains a diagnostic possibility, MRI itself is sufficient to provide a conclusive diagnosis and thus obviate the need for a biopsy [6] Among 50 patients in present study, evaluation of 67 lesions in 47 patients was done while in the rest of 3 patients, 1 patient had multiple regenerating nodules studded in liver in background of cirrhosis, 1 patient had multiple metastatic lesions and another patient had multiple biliary hamartomas in both lobes which were uncountable. 46 patients (92%) were accurately characterized on MRI of 50 patients hence it could accurately characterized 63 lesions in 43 patients and three patients had multiple lesions studded in both lobes of liver (one patient with multiple regenerating nodules, one with multiple metastasis and another with multiple hamartomas) which were also correctly diagnosed. Four lesions in four patients, one lesion each of hepatocellular carcinoma, Metastasis, hepatoblastoma and cholangiocarcinoma, were not correctly diagnosed based on imaging and they were diagnosed based on histopathological examination.

Present study showed higher accuracy (92%) in characterising the focal liver lesions with gadolinium enhanced MRI. Compared to the study done by Huppertz A et

al., [7] where the specificity is 79.8%. They could correctly diagnosed 103 of 129 patients in postcontrast imaging. The high specificity in present study was probably due to small sample size. The study by Y. Yamashita et al., [8] could correctly diagnose 86% lesions among 300 focal liver lesions calculated by logistic progression analysis with morphological characters on T2 weighted images like tumour margin, internal architecture and enhancement characteristics. This study had comparable lesion characterisation rate to the present study (92%). Though we took into account the tumour margin, the findings like internal architecture (T2WI) and enhancement characters were similar and hence similar specificity. The incidence of malignant liver lesions was only 22% (55 lesions) among 254 patients published by Jones et al., [9] and the incidence of HCC was 3 % (3 lesions), metastasis 54 % (12 lesions) and 31% (7 lesions) by Schmiedl U et al., [10]. The incidence of malignant lesions 50% (25) is higher in the present study, as compared to the above studies followed by 42% (21) benign lesions and 8% (4) infective lesions. The maximum number of malignant lesions are found in the age group of 40-60 years in this study who are more prone to develop malignant lesions.

Malignant Lesions

Hepatocellular carcinoma in cirrhotic liver: Cirrhosis is the most important predisposing factor for HCC, with approximately 80% of cases developing on a background of cirrhotic liver in a study [11]. In this study eight patients of cirrhosis with focal liver lesions were evaluated. Benign lesions like hemangioma can be seen and they should be considered as differential with specific imaging characters. Isointensity on T2-weighted images are typical features of well differentiated tumours, while hypointensity on T1-weighted images and hyperintensity on T2-weighted images are usually associated with moderately or poorly differentiated tumors as studied by Lencioni R et al., [11]. There was only one HCC with slightly different characteristics on T2WI that was Iso to hyperintense. This lesion was of low grade malignancy on histopathological examination.

In the present study, most characteristic MRI finding suggestive of HCC was early arterial enhancement with rapid washout in subsequent phases due to Arterio-venous shunting in the hypervascular HCC. This finding is well described in the literature [12] in 6 (85%) of 7 HCCs in cirrhosis. In a study by Jorge A et al., in 66 patients, arterial enhancement was present in all 66 patients with HCC in cirrhotic patients. By contrast, delayed hypointensity of the arterially enhancing mass was present in 89% of the patients with HCC with Sensitivity of 89% and Specificity of 96% for HCC. Study by Marrero JA et al., [12] infers that HCC usually becomes hypointense in the portal venous and delayed phases and often shows a delayed enhancing outer rim of capsule. These features are highly specific for HCC, with a reported overall sensitivity of 89% and specificity of 96% for delayed hypointensity. Hence, Dynamic contrast enhance MR should be performed in all patients with focal liver lesions for better characterisation.

Hepatocellular carcinoma in non-cirrhotic liver: In this study, three patients presented with HCC in non-cirrhotic liver. All the lesions (100%) were Hypointense on T1 weighted and hyperintense on T2 weighted. HCC in non-cirrhotic liver are smaller than in cirrhotic measuring less than 4 cms in contrast to the study done by Winston CB et al., [13], which reviewed MR images in 36 patients with HCC and observed that lesions in cirrhotic livers differed significantly from those in non-cirrhotic livers in terms of size.

Vascular involvement like encasement and invasion into the adjacent vessel is a finding indicating malignancy. We could find vascular invasion (portal vein) in only two patients (22.3%) as most of the lesions are peripherally located and microscopic invasion could not be detected on imaging. In a recent study [14] of 322 patients undergoing curative resection of HCC, 15.5% had macroscopic venous invasion and 59% had microscopic venous invasion at histopathologic analysis.

Metastasis: In this study, eight patients with 19 metastases, excluding one patient with multiple lesions of metastasis to liver were studied. Seven patients were diagnosed cases of primary malignancy and three patients did not have evidence of extrahepatic primary malignancy at the time of MRI examination. These patients were referred for evaluation of liver mass. According to the study by Goldberg A et al., [15] the majority of liver metastases have a higher cellular and interstitial water content of tumour tissue compared to normal liver parenchyma which renders metastases hypointense on non-enhanced T1-weighted images and hyperintense on T2W images [15]. In the present study, 18 (94.7%) lesions were hyperintense on T2 and one lesion was hypointense with hyperintense rim which was hemorrhagic metastasis from CA rectum.

Intense perilesional enhancement of metastases on gadolinium enhanced MR images correlates with histopathologic hepatic parenchymal changes, which include peri-tumoral desmoplastic reaction, inflammatory cell infiltration, and vascular proliferation [16]. Two lesions (10.5%) showed persistant heterogeneous enhancement in all phases. One was metastasis from CA rectum and another lesion was metastasis from operated HCC.

Cholangiocarcinoma: In this study, three lesions of cholangiocarcinoma were studied, two in females and one in male. They were presented with pain, anorexia, weight loss, jaundice and lump. The lesions were hypoechoic on ultrasound. Two lesions were diagnosed accurately on MRI as lesion showed typical delayed enhancement in equilibrium phase with additional features of proximal biliary dilatation.

Similar enhancing characters are also described by Yoji Maetani et al., [17] in a study of 50 patients and showed that on contrast, lesions showed patchy peripheral enhancement in arterial or portal venous phase followed by progressive centripetal enhancement in delayed phases.

Hepatoblastoma: Two lesions of hepatoblastomas were studied and both were female patients. One lesion was involving entire right lobe while other was noted to be involving both lobes. The lesions were T1 hypointense with

hyperintense areas suggestive of hemorrhage within. They were heterogeneously hyperintense on T2 weighted images with areas of haemorrhage and necrosis. There was peripheral discrete nodular enhancement in arterial enhancement. Portal and equilibrium phase showed increased heterogenous patchy enhancement. With these imaging features and age of patient, one lesion was characterised as giant hemangioma while the other was diagnosed as hepatoblastoma. Patient were operated and histopathology proven to be hepatoblastoma.

Study done by Dachman AH et al., [18] showed on MRI that the hepatoblastoma appears as a heterogeneous isointense or hypointense mass on T1-weighted un-enhanced images with variable haemorrhage and intermediate intensity seen on T2-weighted images. During the arterial phase of dynamic Gd-enhanced imaging, the lesion becomes heterogeneously hyperintense, except for the fibrotic and necrotic areas. On portal venous and equilibrium phases, the tumour rapidly appears isointense and subsequently hypointense.

Benign Lesions:

Hemangiomas: In this study seven patients (16 lesions) with hemangioma were studied. Five (31.2%) of them were giant hemangiomas (more than 6 cm) with average size of 13 cm while rest 11 (68.7%) were small hemangiomas with average size of 2.5 cm. One patient had hemangioma in background of cirrhotic liver. On T1W images, all (100%) hemangiomas were hypointense. However larger hemangiomas were hyperintense on T2W imaging

On T2-weighted images hemangiomas demonstrate a markedly bright signal as hemangiomas are comprised of blood-filled spaces or vascular channels lined with a single layer of endothelium separated by fibrous septa. There may be areas of thrombosis or fibrosis. Very slow blood flow is characteristic in the lesions [19]. In a study done by Semelka et al., [20], most of the medium (1.5-5 cm), and large hemangiomas (>5 cm) had initial peripheral nodular enhancement, whereas uniform enhancement was observed in 35 of 81 small lesion.

In the present study, all (16 lesions) hemangiomas were correctly diagnosed on MRI because of typical characteristics and contrast enhancement features seen.

Simple and complex cysts: This study had three patients with three complex cysts and two patients with 3 simple cysts. The differentiating features between simple and complex cyst were internal thin septations with few tiny nodules which was seen in complex cysts. There was no post-contrast enhancement in both lesions. Findings were similar to study done by Koenraad J et al., [21].

In their study on MR characteristics of cystic liver lesions, they inferred that the findings like septae, calcification or internal nodules were important in the characterisation of liver cysts as complicated.

Hepatic adenoma: Total five lesions of hepatic adenomas were studied in four patients where three were females in the age group of 20-40 years and one was male. IN PHASE AND OUT OF PHASE imaging was performed in all the patients. Accurate diagnosis was made in all the patients correlating with the history and the lesions were proved to be hepatic adenomas on histopathology.

In the study by Grazioli L et al., [22] showed similar findings of hepatic adenoma. Their study showed, On T1-weighted images, frequently the lesion is heterogeneous in appearance due to areas of increased signal intensity related to fat, glycogen or recent hemorrhage, and low signal intensity areas corresponding to necrosis or old hemorrhage. About one-third of adenomas have a peripheral rim, corresponding to a fibrous capsule; frequently the rim is of low signal intensity on both images.

Focal nodular hyperplasia: This study had two lesions of focal nodular hyperplasia, both were typically well-defined with clear-cut margins, uncapsulated, yet hypoechoic on ultrasound. Lesion showed arterial enhancement and washout in portal phase with enhancing scar in equilibrium phase. It was proved on histopathology. Similar findings were reported by Mortele KJ et al., [23] in 48 patients with FNH, On T1- and T2-weighted images, lesions appeared predominantly hypointense (69.5%) and hyperintense (72.7%), respectively.

Regenerating nodules: This study had one patient with multiple regenerating nodules in background of cirrhotic liver which were involving both lobes heterogeneously hypoechoic on ultrasound. All the lesions were hypointense on T1 and T2 weighted images with no post-contrast enhancement. With the typical imaging findings, patient had no further work-up done. Lencioni R et al., [11]. study showed similar characters in regenerating nodules. Lesion signal intensity on baseline T1-weighted and T2-weighted images may help differentiate HCCs from regenerating nodules in cirrhosis [24].

Hydatid cysts: Two lesions of hydatid cysts of the liver were evaluated. In both the patients, lesions were well-defined with smooth margins. They were hypointense on T1W images and hyperintense on T2WI with low intensity peripheral rim. Peripheral rim was more apparent in T2W images. Minimal enhancing peripheral low intensity rim was seen in both (100%) and is characteristic finding of hydatid cyst. Both the patients were operated and proved to have hydatid cysts on histopathology

Similarly, Wojtasek DA et al., [24] studied the MR characteristics of hepatic hydatids and found out that the low signal intensity rim described on T2WI was not found in all cases and that MR was superior to other modalities in delineating the internal contents of the hydatid cyst. This finding was seen in both lesions of the present study. Kodama Y et al., [25] studied MR characteristics of 50 liver hydatid cysts. In both the lesions in the present study, we did not find daughter cysts, probably because one lesion was ruptured and also due to small sample size.

Abscesses: Two lesions of liver abscesses were studied. Both lesions showed thick wall (100 %). Both the lesions (100%) were hypointense on T1W and hyperintense on T2W images. One lesion (50%) showed peri-lesional edema. Post-contrast, both lesions showed peripheral enhancement in all the phases. They were proved to be abscess on FNAC with causative organism being staphylococcus and klebsiella respectively.

Findings were similar to the study done by Mendez RJ et al., [26]. Which showed MR imaging increased the peripheral rim enhancement. Peri-lesional edema is seen on T2-weighted MR images in 50% of abscesses, although it may also be seen in 20%- 30% of patients with primary or secondary hepatic malignancies [26]. Therefore, the presence of peri-lesional edema can be used to differentiate a hepatic abscess from a benign cystic hepatic lesion [26]. This was seen in one lesion of the present study.

5. Limitations

Firstly, small sample size was the limitation of the study. Secondly, selection bias might be there as all subjects of the study were selected on basis of Ultasound examination. Thirdly, Magnetic Resonance Imaging involves breath holding with long procedure time which creates issues to many patients even after being a good diagnostic modality.

6. Conclusion

MRI is superior as compared to other modalities like ultrasound and CT in having high spatial resolution with multiple sequences like T1, T2 and fat suppression techniques like IN PHASE, OUT OF PHASE helps in demonstrating lesion characters like architecture, margin, haemorrhage, fat component and vascular invasion of the lesions. MRI is a modality of choice for focal liver lesions in patients with contraindications for Computed Tomography like pregnant patients, paediatric patients and contraindication for iodinated contrast like patient with renal dysfunction. MRI is valuable for the characterization of focal liver lesions detected on Ultrasonography. Basic MRI sequences along with chemical shift imaging sequences and dynamic contrast imaging has significant role in characterising and differentiating the focal liver lesions.

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