

Original Research Article

Evaluation of focal liver lesions by magnetic resonance imaging and correlation with pathology

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ABSTRACT

Background: The goals of imaging in focal liver lesions is to assess the number, size, location and characterize the lesions as benign / malignant with newer imaging modalities and confirmation of pathology by Fine needle aspiration cytology or by biopsy. This is essential for treatment planning and prognosis.

Methods: A total of 42 patients detected to have focal lesions in liver on ultra-sonogram were characterized on MRI on the basis of morphology, signal characteristics, enhancement patterns. Extra hepatic spread is suggested by capsular breach, peritoneal metastases and lymph node enlargement. Tissue diagnosis was obtained by fine needle aspiration cytology/ Tru cut biopsy/ surgery. Hemangiomas and simple cysts were followed up for an average period of 7.5 months by imaging without biopsy.

Results: Out of 42 patients, 28 were males (68%) and 14 were females (32%). The age range was 20 to 70 years with a mean age of 51 years for malignant lesions. The right lobe of liver was involved in 26 (62%), left lobe in 7 (17%) and both lobes in 9(21%) cases. There were 24 benign and 18 malignant lesions. The mean ADC value was 2.092×10^{-3} sec/ mm² and 1.241×10^{-3} sec/ mm² for benign and malignant lesions respectively. The difference in mean ADC values in both the groups was significant ($p < 0.0001$).

Conclusions: MRI was able to predict diagnosis in 38 of the 42 lesions (90%) which were proved on pathology or by follow up imaging. MRI could not provide specific diagnosis in two early abscess, one each of multifocal hepatocellular carcinoma and regenerative nodules. Thus MR imaging is a powerful tool for the evaluation of focal liver lesions.

Keywords: Focal liver lesions, MRI Liver, Liver metastases, Liver abscess, Hemangioma liver

INTRODUCTION

Liver lesions are one of the most commonly encountered lesions. Annually thousands of patients undergo imaging for the work up of suspected or known liver masses.

The main goals of imaging are to assess the number, size, location of the lesions relative to the vessels and nature of the lesions. The exact prevalence of benign liver masses

is unknown but some studies suggest that they may be found in more than 20% of the general population.¹ Recent studies suggest that small (<15 mm) lesions that are detected on CT are benign in more than 80% of the patients who have known malignancy.² With the application of MDCT and thin collimation, it is likely that more liver lesions will be detected that will need additional imaging for characterization, most likely with MR imaging.

In patients with cirrhosis, early diagnosis of malignant changes is of vital importance as liver transplantation offers the best chance for survival. Recognizing dysplastic and regenerative nodules and early hepatocellular carcinoma helps to control tumor burden at early stages by nonsurgical techniques while awaiting transplantation as well as stratifies the patients who have favourable long term results with transplantation.

It is also important to distinguish benign and malignant liver lesions. Several malignancies, such as breast, pancreas and colorectal tumors metastasize to liver. The survival rate following the resection of isolated metastasis especially in colorectal malignancies can be as high as 38%.³

MRI is particularly well-suited for the evaluation of benign vs malignant liver pathology, diffuse processes such as abnormal fat in non-alcoholic steato hepatitis and iron accumulation in hemochromatosis due to its ability of high soft tissue contrast and multiplanar images.

The use of intravenous gadolinium-based contrast agents allows evaluation of the vascular nature of benign and malignant tumors. Unlike MDCT, there is no Ionizing radiation with MRI. MRI can be very useful for confirming the diagnosis of Hemangioma, focal nodular hyperplasia, complex cyst, etc. without the need for biopsy, surgery, or multiple follow-up examinations.

The main concern for use of MR imaging is its limited availability and high cost making its use as a problem solving modality till now. In near future MR imaging may be applied as first line modality with similar or greater accuracy, which may enable faster diagnosis and decision making.

The longer scan times, motion artifacts associated with the conventional spin echo sequences are now overcome by the gradient echo, fast spin echo and fat saturation techniques.

Diffusion weighted imaging enables qualitative and quantitative assessment of tissue diffusivity (apparent diffusion coefficient) without the use of gadolinium chelates, which makes it a highly attractive technique, particularly in patients with severe renal dysfunction at risk for nephrogenic systemic fibrosis.

Aims and objectives

1. To assess the lesion characterization potential of MRI by evaluating unenhanced and dynamic gadolinium enhanced sequences
2. Pathological correlation of the lesions to explain the major MRI findings.
3. Assessment of the lesions by diffusion weighted imaging and investigating the role of b value in differentiating malignant and benign lesions

METHODS

A total of 42 consecutive patients from December 2013 to August 2015 were referred to the department of Radio diagnosis, King George Hospital, Visakhapatnam who were diagnosed to have focal liver lesions by sonography were included in the study after informed consent and the study was approved by the ethics committee. In all studies MR imaging was performed on 1.5 T systems (General electrical medical systems). A dedicated phased-array body coil was used.

Sequences

1. Axial T2-weighted FSE with TR/TE 1826/180, Field of view 40x40cm, Matrix 256 x 256, Slice thickness 5mm with inter slice gap of 2.5mm, number of excitations (NEX) = 0.5
2. Axial pre contrast LAVA with TR = 4.4, TE = 2, slice = 5 mm with interslice gap of 2.5mm, average MA = 320 x 160, NEX = 0.7 Axial in phase and opposed phase 2D SPGR sequences were acquired.
3. Diffusion-weighted respiratory-triggered single-shot spin echo echoplanar imaging (SS SE-EPI) sequence using b -values 600 s mm^{-2} . The quantitative analysis of the diffusion (ADC) was calculated on a workstation by applying a ROI on the image.
4. Dynamic Gd-enhanced MR imaging using the fat-suppressed Multiphase LAVA was subsequently performed in the arterial, portal venous phases and equilibrium phases. The imaging parameters were kept identical.

A power-injector was used for the gadolinium injections (Omniscan, GE health care, 0.1 m mol/kg body weight; injection rate 2 ml/s). Liver-specific contrast agent agents were not included in our clinical routine.

Arterial dominant phase

20 to 40 seconds after the initiation of contrast and it captures the "first pass" or capillary bed enhancement of tissues. Demonstration of gadolinium in hepatic arteries and portal veins, and absence of gadolinium in hepatic veins are reliable landmarks.

Portal venous phase or early hepatic venous phase

45-60 seconds after the initiation of contrast injection in which phase, maximum hepatic parenchyma enhances and so the hypo vascular lesions such as cysts, hypo vascular metastases and scar tissue can be clearly delineated as hypointense lesions.

Hepatic venous phase or interstitial phase

It starts at 90s-5 minutes after the administration of contrast. Delayed or late enhancing focal liver lesions are best characterized in this phase

Image analysis

On the basis of morphology, signal characteristics, enhancement patterns in arterial, portal, venous and delayed phases and diffusion/ ADC maps, the lesions were characterized. The sizes and numbers of liver lesions as well as the hepatic segments involved were recorded for the solid lesions.

Couinaud’s anatomical description of eight liver segments for lesion localization was used. Coexisting benign lesions such as hemangiomas and cysts were also noted. The anatomical proximities of the lesions and to the inferior vena cava or hepatic veins, hepatic hilum, and to the main portal branches were assessed. For this purpose, a scale for the lesion’s proximity of less than 1 cm or more than 1 cm was used. Benign or suspected malignant lymph nodes were scrutinized and the possibility of other extra hepatic involvement such as infiltration through the hepatic capsule or peritoneal metastases were considered

Pathology

Tissue diagnosis (Fine needle aspiration cytology/ trucut biopsy) is obtained in feasible cases. In case of patients with hemangiomas and simple cysts either follow up (average 7.5 months) or post-surgical histopathology has been considered.

RESULTS

The present study included 42 patients of which 28 were males (68%) and 14 were females (32%). The male female ratio was 2:1 approximately. The age range of the study group was 20 to 70 years with most patients falling between 30 to 60 years. The mean age for malignant lesions was 51 years. The right lobe of liver was involved in 26 cases (62%), left lobe in 7cases (17%) and both lobes in 9 cases (21%). There were 24 benign and 18 malignant lesions.

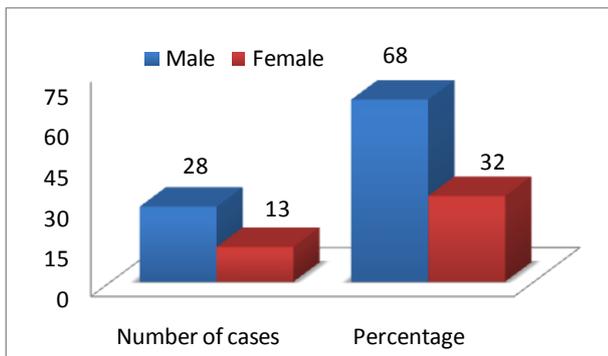


Figure 1: Male versus female distribution of liver lesions.

Abscess and hemangiomas were predominant in benign whereas metastases and hepatocellular carcinomas were

predominant in malignant lesions. The mean ADC value of benign lesions was $2.092 \times 10^{-3} \text{ sec/mm}^2$ and that of malignant lesions was $1.241 \times 10^{-3} \text{ sec/mm}^2$. The difference in mean ADC values in both the groups was significant ($p < 0.0001$). MRI could characterize 92% cases.

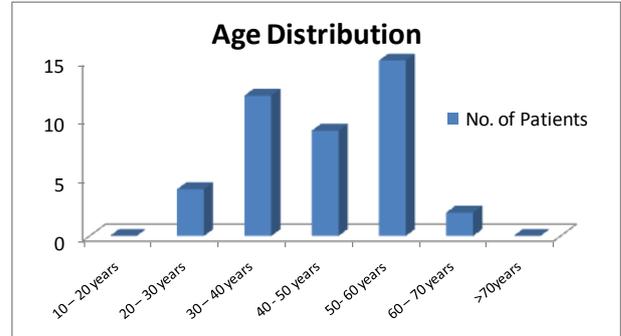


Figure 2: Age distribution of liver lesions.

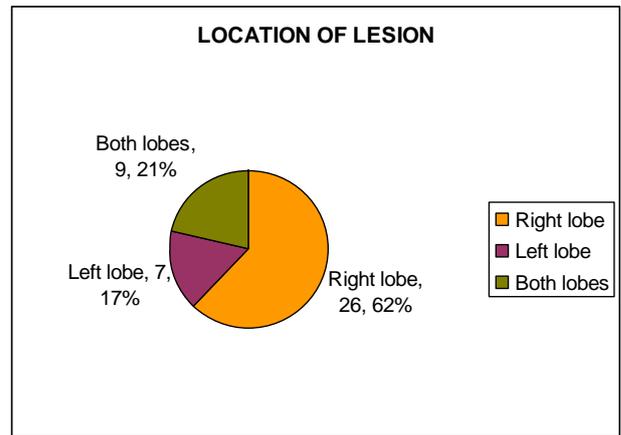


Figure 3: Location of lesions in right versus left lobes.

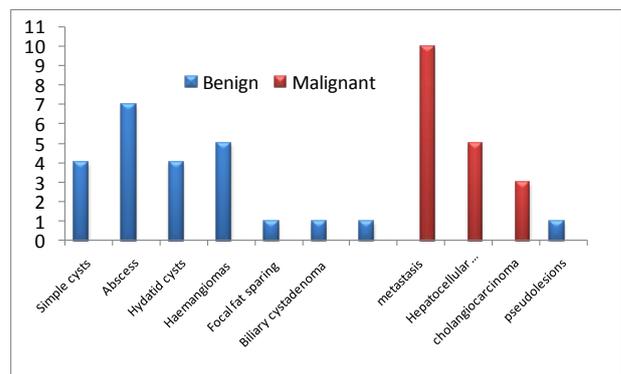


Figure 4: Type and number of benign versus malignant lesions.

Based on MR Imaging 92% of lesions were accurately characterized and diagnosed of which 90% were done on T1W Gadolinium enhanced images alone and 80% on DWI-b value, 62% on T2WI and 54% on LAVA

sequences. On the Gd enhanced images four cases of HCC and one case of Focal Nodular Hyperplasia revealed homogenous enhancement and inhomogeneous enhancement was observed in one case of HCC. Complete ring enhancement was seen in eight cases of metastases and one case of Hemangioma whereas incomplete ring enhancement was seen as in one case of metastasis. Peripheral puddles of contrast enhancement is diagnostic of hemangiomas, was seen in three cases.

Table 1: Incidence of benign and malignant lesions.

Lesions	Nature of the lesions	
	Benign	Malignant
Simple cysts	4	
Abscess	7	
Hydatid cysts	4	
Haemangiomas	5	
Focal fat sparing	1	
Biliary cystadenoma	1	
Focal nodular hyperplasia	1	
Metastases		10
Hepatocellular carcinoma		5
Cholangiocarcinoma		3
Pseudolesions	1	
Total	24	18

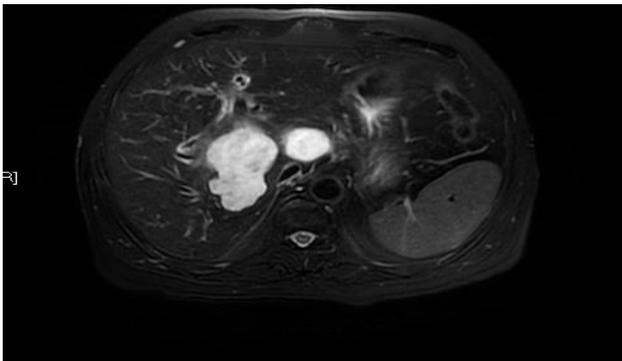


Figure 5: Liver abscess: axial T2WI shows hyper intense lesion in segment I and VII of the liver.

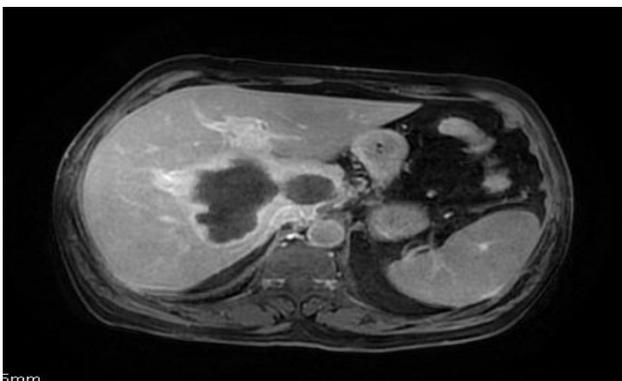


Figure 6: Liver abscess: on axial post contrast delayed phase- ring enhancement around the lesion with thick wall, peri lesional enhancement.

The mean ADC value of benign lesions was 2.092×10^{-3} sec/ mm² and that of malignant lesions was 1.241×10^{-3} sec/ mm². The difference in mean ADC values in both the groups was significant ($p < 0.0001$). The threshold ADC values to distinguish the above two groups was determined to be 1.43×10^{-3} sec/ mm² by ROC analysis. The area under the curve is 0.922 and the standard error is 0.066.

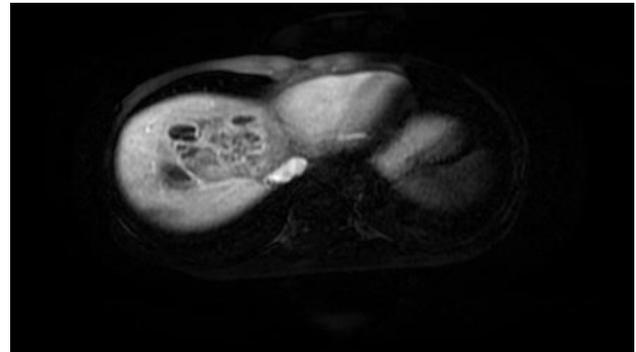


Figure 7: Pyogenic abscess: axial post contrast image showing cluster of lesions with peripheral rim enhancement.



Figure 8: Polycystic liver: MRCP sequences show multiple hyper intense lesions in both lobes of the liver, without any communication with bile ducts.

DISCUSSION

The study was done on 42 patients of sonographically detected focal liver lesions for whom MRI was done in all the lesions and contrast was given in 38 members. Focal liver lesions were analyzed based on clinical findings, laboratory investigations and MR imaging. Tissue diagnosis (FNAC/ Biopsy), surgery were done in feasible cases. In other cases, where surgery/ tissue diagnosis is not possible/ not indicated, follow up was done from three to twelve months with an average period of 7.5 months.

MR imaging

MR imaging was done in all 42 cases. We considered multiple lesions of similar morphology in a single patient as a single lesion. Metastases are the most common

malignant lesion and abscesses are the most common benign lesions. The size of the lesions varied from 0.7cm to 14 cm with an average of 6.3 cm for malignant lesions and 5.5cm for benign lesions. The size of the lesions is not predictive of the malignant character of the lesion.

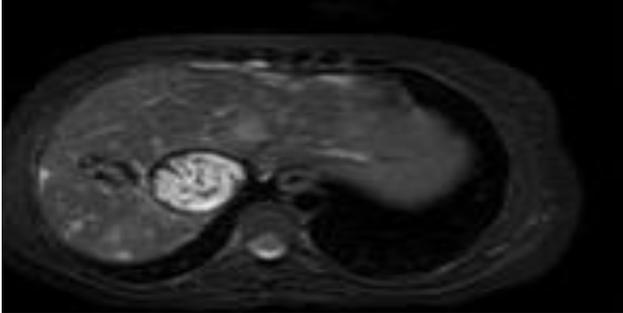


Figure 9: Hydatid cyst: axial T2 WI show hyper intense lesion with undulating membranes and another hypo intense lesion (calcified lesion) adjacent to it.

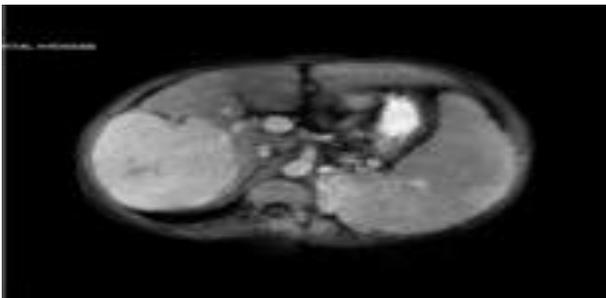


Figure 10: FNH: axial post contrast images show intensely enhancing lesion with central scar.

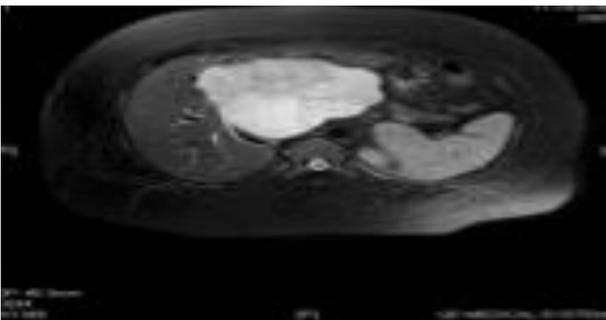


Figure 11: Hemangioma: axial T2 WI shows a lesion which is intensely hyper intense on T2 WI.

Lesion detection

Of the total Lesions detected by contrast enhanced sequences, 92% were detected on T2WI and 97% were detected on diffusion weighted images. Diffusion weighted images were able to detect small metastatic lesions which were inconspicuous on T2 weighted images. These small lesions were also identified on gadolinium enhanced scans. According to Parikh et al, the malignant focal liver lesions detected by DW imaging

[86.4%] was significantly greater than that detected with T2-weighted imaging (62.9%).⁸

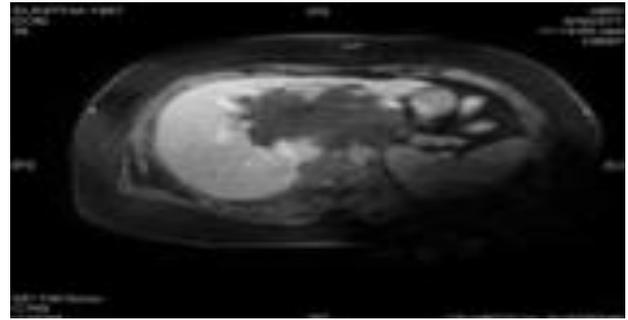


Figure 12: Same lesion in Figure 11, shows peripheral puddling in early portal phase of contrast study.

But this statistical significance is lost with increasing size of the lesions. In our study the average size of the malignant lesions was 6.3cm. Hence the detection rates of the lesions were higher as well as the significance of DW imaging is decreased. In a study by Obuz F et al overall MR imaging sensitivity for detection of small lesions (<1 cm) was 13- 67%, while for large lesions (>3 cm) it was 100%.⁹

When assessed for image quality, the T2 weighted images have the best quality and less number of artifacts. The cystic lesions were more conspicuous on T2 weighted images whereas metastases were conspicuous on DW imaging. This is in accordance with the study by Coenegrachts et al which highlights SE-EPI DWI as a promising technique for detecting small (<10 mm) focal malignant liver lesions.⁵ The reason for a high detection rate of focal hepatic lesions on DWI is attributed to the better contrast-to-noise ratio and better lesion conspicuity by suppression of background vessels.⁸

Furthermore, the solid tumors tend to appear larger on DWI than on T2 weighted images⁷. This phenomenon may contribute to the high detection rate of small solid tumors on DWI.^{7,8} Although the use of T2 weighted images is helpful for the detection of the focal hepatic lesions, lesion detectability is suppressed by low lesion-to-liver contrast and the interfering high signal intensity from intrahepatic vessels.^{6,10,11} Intrahepatic vessels may be seen as false positive lesions on T2 weighted images. Small benign solid tumor might not be detected on T2 weighted images because of less conspicuity of the solid lesions by the magnetization transfer effect.¹² However in our study when compared with contrast enhanced sequences DW imaging detected lower number of lesions (97%). Combined use of DW imaging and contrast enhanced scans provide highest sensitivity for lesion detection.

Lesion characterization

The results show that the classification into malignant and benign liver lesions and the assessment of specific

diagnosis were most reliably achieved when all sequences were collectively evaluated. Several previous investigations also advocate the use of a combination of sequences in lesion diagnostics. Coulam et al reported a sensitivity of 97% and a specificity of 95% in revealing clinically relevant focal liver lesions using a T1-weighted multiphase contrast-enhanced 3D sequence.¹³

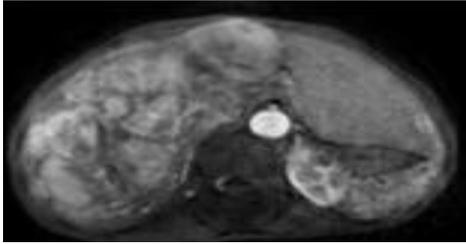


Figure 13: HCC: intense arterial phase enhancement and wash out.

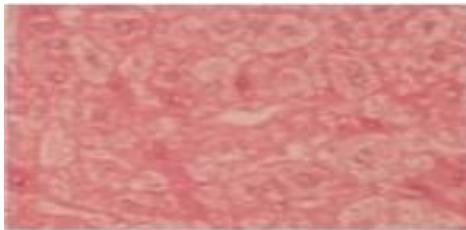


Figure 14: H&E stained sections of HCC show tumor tissue arranged in sheets and lobules with individual cells showing pleomorphism.

Similar results are encountered in the present study. According to the present results, the best individual sequence in distinguishing between malignant and benign liver lesions is the dynamic Gd-enhanced T1-weighted sequence.

This sequence also demonstrated the highest success in the assessment of specific diagnosis, with a 90% rate of correct diagnosis. Several previous studies support this result as Gd-enhancement, particularly when used in a dynamic fashion in different phases of enhancement, has been considered to be highly important in liver tumor characterization.

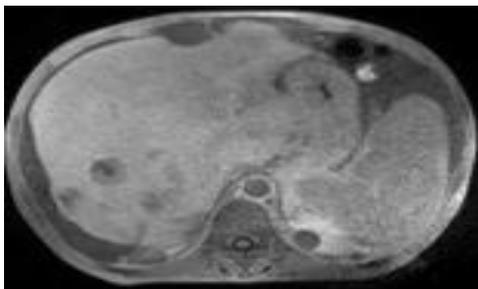


Figure 15: Regenerating nodule: delayed phases show central enhancement with nodular contour of liver – s/o regenerative nodules.

As shown by the results of this study, the unenhanced T1-weighted sequence is of limited value in lesion characterization. Only 54% of lesions were correctly classified and specific diagnosis was assessed in 46% of cases. The T1-weighted sequence is, however, useful for the evaluation of hemorrhagic lesions, tumors with a high fat or copper content such as hepatocellular carcinoma and hepatic adenoma, and lesions that contain melanin such as melanoma metastases. All these lesions may demonstrate high signal intensity in unenhanced T1-weighted images.¹⁴

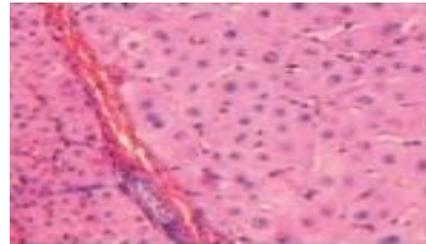


Figure 16: H&E section shows altered hepatic architecture with large cell dysplasia in regenerating nodule.

T2 weighted images are limited in characterization of malignant liver lesions as they have varied appearances. They are more important in imaging of hemangiomas. Reduced lesion conspicuity and the overlap in signal intensity characteristic of benign and malignant nodules diminished the diagnostic value of T2-weighted images in cases of cirrhotic liver, too. McFarland et al found that Hemangiomas and malignant tumors are better differentiated with use of T2 relaxation times obtained with a more heavily weighted T2- sequence (T2 : 140 s).⁴

In present study out of 4 hemangiomas T2 WI was able to characterize three of them. All the three hemangiomas had high signal intensity on T2 WI and heavily weighted T2 sequences. But as some of the hypervascular metastasis also had longer T2 relaxation times, contrast examination was done in all these cases of T2 hyper intense lesions. One patient with carcinoid metastasis revealed longer T2 relaxation times. The fourth patient with Hemangioma had a large lesion and had varied appearance on T2 WI. Contrast enhancement was diagnostic in that patient with puddles of contrast on portal phase and centripetal contrast filling. Overall T2WI has a detection rate of 92% in our study.

Benign lesions were seen in 19 patients in our study. Of these there were two simple cysts. These cysts were detected incidentally in one patient with pancreatitis and the other patient had bladder malignancy. These cystic lesions showed well defined thin wall with intense hypo intense signal on T1 WI and intense hyper intense signal on T2 WI which increased on heavy T2 sequences. These lesions showed no enhancement on contrast administration. These lesions were followed up with sonography which showed no increase in size and

number of the lesions. One patient had polycystic liver disease with multiple well defined cystic lesions without any communication with biliary system. All the cysts were intensely hypo intense on T1 WI without any evidence of hemorrhage. One patient had segmental Carolé's disease with multiple cystic lesions which represent dilated non obstructed biliary radicals. Multiple intracystic calculi were found within them. All the cystic lesions were is to moderately hyper intense on DWI.

Hydatid cysts were seen in four cases. The daughter cysts were hypointense on T1 WI and hyperintense on T2 WI with hypo intense thick rim of pericyst. One cyst was unilocular. There were detached membranes in one case with breach of the wall of the Hydatid cyst. Contrast administration was not done in these cases. These findings were correlating with the study by Marani SA et al¹⁵ which showed the peripheral hypointense rim as a distinguishing feature of Hydatid cysts. Surgery was done in all these cases and the imaging findings were substantiated. The hypointense rim of the Hydatid cysts is due to the fact that the pericyst is rich in collagen that has short T2 relaxation times and it calcifies earlier than the other two inner layers.¹⁵

There were seven cases of abscess. Five of the cases were pyogenic abscesses and two of them were amoebic liver abscess. The lesions were hypointense on T1 WI and hyperintense on T2 WI. Perilesional edema is seen around four of lesions (57%). This is not specific for abscesses as it is also seen with malignancies, but is useful for characterization as mentioned by Mendez et al.¹⁶ One patient in acute stage showed cluster of high signal intensity lesions. This grouped appearance is suggestive of pyogenic abscess.

The differentiation of simple cysts, abscess and Hydatid cysts was possible with diffusion weighted imaging and calculating the ADC values. The mean ADC value of simple cysts and Hydatid cysts (3.02×10^{-3}) was significantly higher than the mean ADC value of the abscesses (1.1×10^{-3}) in our study. These results were in accordance with the studies by Inan et al and Chan et al.¹⁸

Biliary cystadenoma was seen in a single patient, is multiseptated lesions with hypointense signal on T1WI and hyperintensity on T2 WI. On contrast administration there is enhancement of the capsule and internal septations. Differentiation from Hydatid cyst is difficult, but enhancement of the internal septae with no evidence of daughter cysts and demonstration of vascularity within the internal septations on color Doppler was diagnostic.

Korugu et al describe one case of biliary cyst adenoma and one case of Cyst adenocarcinoma. Differentiation of both these lesions was difficult but presence of mural nodules and septal thickening are important features to say cystadenocarcinoma. In our case no definite soft tissue nodules were found. Surgical excision was done and the lesion was found to have cubical biliary type

epithelium surrounding ovarian like stroma on microscopy which is diagnostic of benign biliary cystadenoma.

Focal nodular hyperplasia is another benign entity seen in a young female with idiopathic pulmonary and portal hypertension. There is evidence of large homogenous lesion which is hypointense on T1WI and isointense on T2WI with a central scar that is hyperintense on T2 WI. On contrast administration there is intense homogenous enhancement on arterial phase with delayed enhancement of the scar. Two small additional lesions were identified on contrast administration, which were missed on T1 and T2 WI due to the isointensity of the lesions. In a study by Vilgrain et al, of 37 patients with pathologically proven focal nodular hyperplasia, only eight patients (22%) had multiple lesions.¹⁹

For the association between FNH and pulmonary hypertension, it has been suggested that chronic congestion of the hepatic sinusoids can prolong the exposure of the liver to blood-borne hepatotrophic substances that induce a hyperplastic response of the hepatic parenchyma, and this stimulates the growth of nodular hepatocellular lesions such as FNH, which is a compensatory vicious cycle. Portman et al described a case of nodular transformation of liver in case of non-cirrhotic portal hypertension and pulmonary hypertension.

Lee IJ et al described radiological findings in a case of multiple focal nodular hyperplasia associated with portal vein atresia and portopulmonary hypertension. Ultrasound guided Biopsy showed dense fibrous septum with vascular structures and adjacent hepatic parenchyma showing increased cell plate thickening.²¹ The dense cellularity is responsible for the hypointense signal intensity on T2 WI and the vascularity for the intense arterial phase enhancement.

Of the 42 cases imaged, 18 patients had malignant lesions. Hepatocellular carcinoma was seen in 5 cases of which, three were solitary lesions and two were multiple nodules. All the cases were hypointense on T1 WI and hyperintense on T2 WI. Three of the lesions showed, central hyperintensity which corresponded with necrotic areas on pathology. These areas were non-enhancing on contrast administration. Hypo intense areas on T2 WI were noted in two of the cases which corresponded with fibrotic areas. Tumor capsule was noted in four cases. This is a characteristic sign of large HCCs.

The tumor capsule becomes thicker with increasing tumor size. It is hypointense on T1 and T2 weighted images. Contrast enhancement was either homogenous or variegated in arterial phase. The variegated appearance is due to abnormal internal vessels in the lesion. In one study by Matilde et al, in a total of 31 patients with hepatocellular carcinoma, 13 lesions showed homogenous enhancement, 9 lesions showed variegated

appearance and 7 lesions showed ring enhancement and two of them showed no enhancement.²² In present study 4 patients showed homogenous enhancement and one patient showed variegated appearance. The lesion which showed mosaic pattern on T2 weighted images showed heterogeneous enhancement on gadolinium-enhanced images.

The mosaic pattern on T2 weighted images is due to the histopathology of the tumor. Tumor which showed variegated appearance had confluent nodules that are separated by thin septae and necrotic areas within the tumor on histopathology. This reflects the characteristic growth pattern of HCC. Portal vein encasement is seen in one case. Portal vein involvement is seen more often in infiltrative type of HCCs.

Of the 10 metastases, two were from pancreatic adenocarcinoma, one from gallbladder malignancy, two from gastric neoplasms (one GIST and one gastric carcinoma), one was adeno carcinomatous deposit from unknown origin, one from Carcinoid bowel and three from colon malignancy. The metastases from bowel were having typical target like appearance on T2 weighted images.

All the metastases were having intermediate to high signal intensity on T2 weighted images. These lesions were not as bright as cysts and hemangiomas. On contrast administration 9 of these 10 lesions showed ring enhancement with complete pattern. One metastasis showed incomplete ring pattern.

Perilesional enhancement was seen with one case with metastases from pancreatic adenocarcinoma. All the lesions were bright on diffusion weighted imaging with an average ADC value: 1.34×10^{-3} . In one study by Matilde et al out of 47 patients with metastases, 40 lesions showed ring like enhancement, one lesion showed incomplete ring, and 7 lesions showed no enhancement.²²

Of the 3 cases with intra hepatic Cholangiocarcinoma, hypo intense area was noted on T2 weighted images in two cases corresponding with central fibrosis. There is peripheral intrahepatic ductal dilatation in all the three cases. Intrahepatic dilatation is also noted with one hepatocellular carcinoma. Sub capsular atrophy is noted in two cases. On gadolinium administration contrast enhancement is noted in delayed phases (3-5 minutes delayed phase). This is related to the abundant fibrous stroma of the cholangiocarcinoma. This is specific for intrahepatic cholangiocarcinoma.

Maetani Y et al in their study, correlated the imaging findings and pathological features in 50 patients of Cholangiocarcinoma and concluded that the occurrence of a central hypointense area on T2-weighted images is not pathognomonic; however, this finding, which reflects severe fibrosis, appears to be a characteristic marker of intrahepatic cholangiocarcinoma.²³ The presence of

intrahepatic bile duct dilatation may indicate cholangiocarcinoma, although it is difficult to differentiate cholangiocarcinoma from hepatic colorectal metastasis, which might also show biliary dilatation. The mean ADC value of benign lesions (cysts, hemangiomas and benign nodular lesions) was 2.092×10^{-3} sec/mm² and that of malignant lesions was 1.241×10^{-3} sec/mm².

The difference in mean ADC values in both the groups was significant ($p < 0.0001$). The threshold ADC values to distinguish the above two groups was determined to be 1.43×10^{-3} sec/mm² by ROC analysis. ADC values $< 1.43 \times 10^{-3}$ sec/mm² gave a sensitivity of 96% and specificity of 93% for detecting malignant lesions. The causes for false negatives were focal benign solid lesions and early abscesses and false positives were necrotic metastases.

Out of 5 hepatocellular carcinomas, correct diagnosis was made in four cases. One case of multifocal HCC, in view of intense arterial enhancement and multiple lesions of varying sizes, hyper vascular metastases were considered.

One lesion thought to be metastasis, in patient with adenocarcinoma in head of pancreas showing ring enhancement and intermediate signal intensity on T2 weighted images, turned out to be early abscess. The ADC value of the lesion is 1.2×10^{-3} .

Fine needle aspiration and cytology revealed neutrophils and debris. Follow up studies revealed complete resolution of the abscess. Another patient having multiple small ring enhancing lesions in right lobe of liver with target appearance on T2 weighted images and perilesional T2 hyperintensity and perilesional enhancement was thought to have cystic metastases. Aspirate showed pus within the lesions and follow up studies showed response with antibiotic therapy.

One patient had Budd Chiari syndrome with multiple nodules which are hypo intense on T1 WI and of intermediate signal intensity on T2WI, showing delayed enhancement with contrast. These nodules were indeterminate on MRI as benign regenerative nodules almost never show increased signal intensity on T2 weighted imaging and hepatocellular carcinoma/dysplastic nodules show intense arterial enhancement. Tissue diagnosis showed that these nodules are benign regenerative nodules. Review of literature showed that benign nodules in Budd Chiari syndrome can show increased T2 signal intensity.²⁴

Central area altered signal intensity which is hypointense on T1 weighted images and hyperintense on T2 weighted images is noted in many nodules in this patient which corresponds with central scarring. In a study by Maetani et al of 15 lesions larger than 1 cm in diameter, a central scar was found in six nodules.²³ In the delayed phase of contrast-enhanced imaging, the central scar showed high signal intensity. They concluded that central scar is a

characteristic finding of benign hepatic nodules larger than 1 cm in Budd-Chiari syndrome.²³ Thus MRI was able to predict histological diagnosis in 38 of the 42 focal liver lesions, accounting for 90% of the tumors.

CONCLUSION

Of the 42 tumors, 24 lesions were benign and 18 lesions were malignant. The age group ranged from 18 to 74 years with majority between 40 to 60 years. 61% of the lesions are located in right lobe of the liver. The common benign lesions were liver abscess followed by hemangiomas and the common malignant lesions were metastases.

Contrast enhancement was able to better delineate the cases. Specific pattern of contrast enhancement is typical of certain lesions as homogenous early arterial phase enhancement for hepatocellular carcinoma and ring enhancement in arterial phase for metastases. Delayed enhancement is specific for cholangiocarcinoma. Hemangiomas show peripheral puddling and delayed central enhancement.

Diffusion weighted imaging and ADC value using a cutoff of $1.43 \times 10^{-3} \text{ sec/mm}^2$ is a useful adjunct for determining benign cystic lesions and hemangiomas from malignant lesions.

MRI was able to predict diagnosis in 38 of the 42 tumors (90%). It could suggest the nature of all lesions in benign cysts, hemangiomas, focal nodular hyperplasia and metastases. But it was not possible to achieve a specific diagnosis in two early abscesses, one multifocal hepatocellular carcinoma and one case of regenerative nodules. Pre contrast T1 weighted gradient echo images, T2 weighted images, in phase and out phase imaging, EPI – DWI and gadolinium enhanced T1 weighted images provide accurate characterization of the lesions which correlated well with histopathological /surgical findings. Thus MR imaging is a powerful tool for the evaluation of focal liver lesions. The major limitation in our study was small sample volume.

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