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Original Research Article

A prospective study of MRI in focal liver lesions using 1.5 tesla and its correlation with histopathological findings

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Abstract

Objectives: Focal liver disease is a common diagnostic problem owing to its non specific clinical presentation and marked inter observer variation. Focal masses are usually diagnosed using ultrasonography (USG) and/or computed tomography (CT). Additionally, magnetic resonance imaging (MRI) is preferred when further characterization of these masses is needed. The main objective of this study is to study the accuracy of MRI in the characterization of benign and malignant focal liver lesions and to evaluate sensitivity and specificity of MRI in differentiating various lesions of liver.

Methods: Patients with focal liver lesions detected on USG or CT in a period of 1 year i.e., from October 2012 to November 2013 were subjected for the study in Goa medical college. A total of 60 patients were included in this study. Diagnosis on MRI was made with background of clinical context. Final diagnosis was reached in consensus with biopsy/FNAC, wherever applicable.

Results: In this study 60 patients presented with focal liver lesions 52 lesions were characterized by plain and post contrast MRI specificity of 86.2%. No. of lesions accurately characterized on MRI= 52, Total no. of lesions =60, Percentage = 52/60 = 86.6% In this study, 86.6% of focal liver lesions were accurately characterized on MRI.

Conclusion: MRI is currently considered to be the most accurate non invasive method in the evaluation of liver lesions. Plain and contrast enhanced MR imaging is excellent for evaluating various focal hepatic lesions or at least narrows the differential diagnosis for most of these lesions which helps in the proper management of the patients.

Keywords: Focal liver lesions, Ultrasonography (USG), Computed tomography (CT), Magnetic Resonance imaging (MRI).

1. Introduction

Liver diseases have steadily gained recognition as a major health problem. The symptoms of liver disease such as jaundice, loss of appetite, fever, abdominal distension, fatigue, nausea and encephalopathy are striking phenomena that bring the patient to the physician. Clinical & biochemical examination provide information regarding liver size and functions but the assessment of the exact pathology is grossly inadequate. Focal liver disease is a common diagnostic problem because of its non specific clinical presentation and marked inter observer variation. Focal hepatic lesions include a large series of both benign and malignant lesions such as hepatic cysts, liver abscesses, hemangioma, adenoma, focal nodular hyperplasia, hepatoblastoma, hepatocellular carcinoma, metastases etc.

Today, focal masses are diagnosed using ultrasonography (USG) and/or computed tomography (CT). In addition magnetic resonance imaging (MRI) is preferred when further characterization of these masses is needed. MRI has got many advantages (e.g., high contrast resolution, lack of ionizing radiation, and the safety of using particulate contrast media rather than those containing iodine, ability to obtain image in any plane) that make it a favored modality. Lesion morphology, signal intensity, and contrast enhancement pattern are taken into consideration when characterizing masses with MRI; however, even if the data are taken together, there can still be difficulties in the differentiating benign and malignant lesions.

Despite the fact that MRI has been shown to be equivalent or superior to CT in many hepatic imaging tasks, it still plays a limited role than CT in evaluating liver lesions. Reasons for limited use of hepatic MRI include cost, availability, length of examination and its limitation in evaluation of extra hepatic abdominal diseases. Magnetic resonance imaging has shown considerable utility in the evaluation of focal liver lesions. Modern operative techniques and local therapies such as radiofrequency (RF) ablation are effective methods to treat liver metastases or primary hepatic malignancies. Because the clinical implication of these lesions vary tremendously depending on their causes, the ability to differentiate the more common types of hepatic lesions is very important.

With introduction of MRI contrast agents, MRI study with contrast material enhancement has potential to become the leading imaging modality in evaluation of liver. Extracellular contrast agents have shown to be helpful in characterizing liver lesions. MRI is currently considered to be the most accurate non invasive method in the evaluation of liver lesions The utilization of tissue specific contrast agents such as SPIO (super paramagnetic iron oxide) or MnDPDP (mangafodipir trisodium), the possibility to employ MR techniques that alter tissue contrast such as MT (Magnetisation Transfer) and the multiple slices render MRI as an attractive tool for liver imaging**.**

2) Aims and objectives

- To study the accuracy of MRI in the characterization of benign and malignant focal liver lesions.
- To evaluate sensitivity and specificity of MRI in differentiating various lesions of liver.
- To study the characteristic morphological features of focal liver lesion with pre and post contrast MRI study**.**

3. Materials and methods

3.1 Source of data

The source of data for the study is patients from Goa medical college, referred by clinicians of various departments.

3.2 Sample size:

A total of 60 patients were included in this study. Diagnosis on MRI was made with background of clinical context. Final diagnosis was reached in consensus with biopsy/FNAC, wherever applicable or clinical, laboratory, other imaging features, as well as long term follow up in some patients**.**

3.3 Method of collection of data (including sampling procedure if any):

Patients of all age groups referred for MRI with clinical suspicious of focal liver lesions. Patients with indeterminate lesions detected on USG or CT in a period of 1 year from October 2012 to November 2013 were subjected for the study**.**

3.4 Inclusion criteria:

- All patients referred for MRI with clinical suspicious of focal liver lesions and patients with indeterminate liver lesions detected on USG or CT.
- Incidentally detected focal liver lesions

3.5 Exclusion criteria:

- Aneurysm Clips
- Cardiac Pacemaker
- Implanted Cardiac Defibrillator
- Neuro stimulation System
- Spinal Cord Stimulator
- Cochlear, otologic or other ear implant
- Insulin or other infusion pump
- Prosthesis
- Heart Valve Prosthesis
- Artificial / Prosthetic limb
- Wire Mesh Implant
- Tissue Expander
- Surgical Staples, Clips or metallic Sutures
- IUD, Diaphragm Pessary
- Dentures / Partial plates
- Body Piercing Jewellery

3.6 Equipments

MRI study was performed on a 1.5T Siemens (MAGNETOM Avanto) imaging system with external body array coil, the following sequences were used.

3.7 MRI Protocol

1) T1-Weighted Sequences
2) Spoiled Gradient-Echo (SGE) Sequences
3) Out-of-Phase SGE Sequences
4) Post contrast imaging

Dynamic MR imaging was performed after rapid bolus injection (2.5ml/s) of gadobenate dimeglumine (Gd-BOPTA, MultiHance) and MAGNAVIST. 5 dynamics were taken including 3 minutes equilibrium phase. Delayed 10minute phase was taken wherever required. Following acquisition was taken for Dynamic Gadolinium Enhanced Imaging.

3.8 T1 flash 3d breath holding

TR	:	2.23
TE	:	0.89
FOV	:	400
FOV Phase	:	100
SL	:	2mm

3.9 T1 VIBE FS axial breath holding

TR	:	5.43
TE	:	2.5
FOV	:	350
FOV PHASE	:	75
SL	:	2.5

4. Results and observation

A total of 60 patients who underwent MRI liver examination were included in this study. Distribution and observations in these patients are as follows:

Table 1: Distribution of cases (N-60)

S. No	Pathology	No. of Cases
1	Amebic abscess	7
2	Pyogenic abscess	2
3	Hydatid cyst	4
4	Tubercular abscess	1
5	Hemangioma	11
6	Hepatocellular carcinoma	10
7	Cholangiocellular carcinoma	1
8	Metastases	15
9	Hepatic adenoma	3
10	Simple cysts	6
Total		60

Most common malignant lesion studied was metastasis 15 of 26 (57.7%) and most common benign lesion studied was hemangioma 11 of 34 (32.3%).

Table 2: Age-wise distribution of studied cases

Pathology	0-20	21-40	41-60	61-80
Amebic abscess		5	2	
Pyogenic abscess		2		
Hydatid cyst		2	2	
Tubercular abscess		1		
Hemangioma	1	6	4	
Hepatocellular carcinoma		1	8	1
Cholangiocellular carcinoma			1	
Metastases		5	8	2
Hepatic adenoma		1		2
Simple cyst		4	2	
Total	1	27	27	5

Benign liver lesions 21 of 34 (61.7%) were predominantly distributed in the age group of 21-40, however malignant liver lesions 17 of 26 (65.3%) are seen to distribute in 41-60.

Table 3: Sex distribution of cases

Pathology	Male	Female	Total
Amebic abscess	5	2	7
Pyogenic abscess	1	1	2
Hydatid cyst	2	2	4
Tuberculoma	1		1
Hemangioma	7	4	11
Hepatocellular carcinoma	10	0	10
Cholangiocellular carcinoma		1	1
Metastases	9	6	15
Hepatic adenoma	2	1	3
Simple cyst	3	3	6
Total	40	20	60

40 of 60 patients (66.6%) were male patients. Among all liver lesions except cholangiocellular carcinoma all the liver pathologies were predominantly distributed in males.

Table 4: MRI findings and diagnosis in 10 patients of HCC

No.	T1W	T2W	DGEI	MRI	Final
1	Hypo	Hyper	Early enhancement with rapid washout with capsule on delayed phase	HCC	HCC
2	Iso-hypo	Iso-hyper	Early enhancement with rapid washout	HCC With DN	
3	Hypo	Hyper	Early enhancement with rapid washout	HCC	HCC
4	Hypo	Hyper	Early enhancement with rapid washout with capsule on delayed phase	HCC	HCC
5	Hypo	Heterogenously-hyper	Early enhancement with rapid washout with capsule on delayed phase	HCC	HCC
6	Hypo	Hetrogenosouly-hyper	Early enhancement with rapid washout with non enhancing areas within	HCC	HCC
7	Iso-hypo	Hyper	Early enhancement with rapid washout with non enhancing areas within	HCC	HCC
8	Hypo	Iso-hyper	Early enhancement with rapid washout with non enhancing areas within	HCC	HCC
9	Hypo	Iso- hyper	Early enhancement with rapid wash out	HCC	HCC
10	Hypo	Hyper	Early enhancement with rapid wash out	HCC	HCC

Most characteristic feature of HCC was arterial hypervascularity with rapid washout and around 50% showing capsule on delayed phase.

Table 5: MRI findings in 15 patients of metastases

S. No	Primary	T1W	T2W	Post Contrast	MRI	Final
1	Colon	Hypo	Heterogenously hyper	Peripheral rim enhancement in arterial and venous phase	Hypovscular mets	Adenocarcinoma
2	Colon	Hypo	Hyper	Remain hypo/non enhancing	Hypovascular mets	Adenocarcinoma
3	Breast	Hypo	Hyper	Remain hypo/non enhancing	Hypovascular mets	Invasive ductal carcinoma
4	Breast	Hypo	Hyper	Peripheral rim enhancement	Hypovascular mets	
5	Ca rectum	Hypo	Hyper	Remain hypo/non enhancing	Hypovascular mets	Adenocarcinoma
6	Testis	Hypo	Hyper	Remain hypo/non enhancing	Hypovasculr mets	Non seminomatous tumor
7	Rectum	Hypo	Heteto- hyper	Remain hypo/non enhancing	Hypovascular mets	Poor diff adenocarcinoma
8	Breast	Hypo	Hyper	Non enhancing	Hypovascular mets	
9	Stomach	Hypo	Iso- hyper	Non enhancing	Hypovascular mets	GIST
10	Colon	Hypo	Hetero-hyper	Remain hypo	Hypovascular mets	Adenocarinoma
11	Rectum	Hetero-hypo	Hyper	Non enhancing	Hypovascular mets	Poor deff adenocarcinoma
12	Bronchus	Hypo	Hetero-hyper	Peripheral rim enhancing in arterial, progressive filling	Hypovascular mets	Adenocarcinoma
13	Rectum	Hypo	Hyper	Non enhancing	Hypovascular mets	Adenocarinoma
14	Lung	Hypo	Hyper	Non enhancing	Hypovascular	SCC of lung
15	Rectum	Iso-hypo	Iso-hyper	Peripheral rim enhancing in arterial. Non enhancing central area	Hypovascular mets	Adenocarcinoma

Table 6: MRI findings in 3 patients of hepatic adenoma

S. No	T1W	T2W	Other	DGEI	MRI	Final
1	Iso-hypo	Hyper	Inn phase-hyper Opp phase-hypo intense area within	Minimal peripheral enhancement arterial, venous phase	Hepatic adenoma	
2	Iso-hypo Hypo-capsule	Hyper Hypo- capsule	Inn phase- hyper Opp phase-hypointense area within	Enhancement in arterial and venous phase with enahancement of capsule	Hepatic adenoma	Hepatic adenoma
3	Iso-hypo	Hetero-hyper		Minimal enhancement in art and venous phase	Benign liver lesion and follow up	Hepatic adenoma

Among three, two of the patient has intra lesional fat which is one of the feature of hepatic adenoma

Table 7: MRI findings in 11 patients of hemangioma

S. No	T1W	T2W	T2WI with higher TR and TE	DGEI	MRI
1	Hypo	Hyper	Increase in intensity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma
2	Hypo	Hyper	Increase in intensity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma
3	Hypo	Hyper	Increase in intensity as compared to t2	Early and persistent isointense to vessels in all phase	Rapidly Hemangioma
4	Hypo	Hyper	Increase in intensity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma
5	Hypo	Hyper	Increase in intensity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma
6	Hypo	Hyper	Increase in intensity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma
7	Hypo	Hyper	Increase in intensity as compared to t2	Early and persistent isointense to vessels in all phase	Rapidly filling hemangioma
8	Hypo	Hyper	Same as t2w	Early and persistent enhancement	Rapidly filling hemagioma
9	Hypo	Hyper	Increase in intensity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma
10	Hypo	Hyper	Increase in intensity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma
11	Hypo	Hyper	Increase in intesity as compared to t2	Peripheral discontinuous nodular enhancement with progressive centripetal enhancement	Hemangioma

Peripheral discontinuous nodular enhancement with centripetal filling, following vascular intensity is most specific finding in hemangioma.

Table 8: MRI findings in cholangiocarcinoma (CCC)

S. No	T1W	T2W	DGEI	Other features	MRI	Final
1	Hypo	Hetero- hyper	Hypointense with Thin, patchy peripheral Enhancement in arterial Phase with progressive Centrpetal enhancement In delayed phases	Segmental Biliary Dilatation	CCC	CCC

Progressive centripetal enhancement with near complete enhancement in delayed (10min.) phase with biliary dilatation is suggestive of cholangiocellular carcinoma.

5. Discussion

A total of 60 patients were studied. The diagnosis on MRI was made with background of clinical context. Final diagnoses were reached in consensus with biopsy/FNAC, wherever applicable or clinical, laboratory, other imaging modality findings and long term follow up in some patients. Of 60 patients accurate characterization of pathology was obtained in 52 patients.

No. of lesions accurately characterized on MRI= 52

Total no. of lesions =60

Percentage = 52/60 = 86.6%

In this study, 86.6% of focal liver lesions were accurately characterized on MRI

The first clinical liver MRI studies were carried out by Doyle *et al* [1] and Smith *et al* [2] in the year 1981. Smith *et al* [2] used 0.04 T MRI and demonstrated a liver tumor having the same T1 relaxation time with blood and consequently, this tumor was later diagnosed to be a Hemangioma which was verified in operation. Later in 1981, Smith *et al* [3] published a liver NMR (nuclear magnetic resonance) study with a population of 50 patients and then he concluded that the specificity of MRI based on T1 relaxation time calculations is superior to that of ultrasound and radionuclide studies.

Yamashita *et al* [4] analysed the role of spin-echo (SE) and contrast material enhanced dynamic magnetic resonance (MR) imaging in the differential diagnosis of focal liver lesions. Conventional T1 and T2 weighted SE and fast low-angle shot dynamic MR imaging was performed in 300 focal liver lesions by using 1.5-T MR imager. They found that signal intensity on T2-weighted images, tumor margin, and internal architecture were significant factors for SE imaging. For dynamic imaging, the hemodynamic and pattern of enhancement were significant factors. A logistic regression analysis showed 86% of lesions were correctly categorized with these parameters.

Hamm *et al* [5] evaluated prospectively the diagnostic accuracy of non-enhanced and gadolinium-enhanced magnetic resonance (MR) imaging in characterization of hepatic lesions. 55 patients with benign and 52 patients with malignant focal liver lesions underwent MRI using 1.5 T. Receiver operating characteristic analysis showed that dynamic contrast-enhanced MR imaging added further information to non enhanced MR studies and thereby improved distinction between 9 benign and malignant lesions ($P < 0.05$). Clinical data further improved lesion characterization with non enhanced and combined non enhanced and contrast enhanced MR imaging ($P < 0.05$).

Huppertz *et al* [6] analysed the safety and efficacy of gadoxetic acid disodium– enhanced magnetic resonance (MR) imaging in 169 patients with focal liver lesions along with pathology correlation .He found that the number of patients in whom all lesions were correctly matched increased from 89 of 129 patients at precontrast MR imaging to 103 of 129 patients at post contrast MR imaging. The number of patients in whom all lesions were correctly matched and the corresponding sensitivity values increased from 72 (55.8%), 68 (52.7%), and 66 (51.2%) with the pre contrast images to 88 (68.2%), 69 (53.5%), and 76 (58.9%) with the post contrast images and concluded that MR imaging with gadoxetic acid improves lesion detection and accurate localization.

Elizabeth *et al* [7] retrospectively assessed the usefulness of contrast material– enhanced T1-weighted magnetic resonance (MR) imaging alone and with T2-weighted MR imaging in making the diagnosis of hepatocellular carcinoma (HCC). At liver explantation, 57 lesions were present in 18 patients: 19 HCCs, 33 dysplastic nodules, and five cysts. Contrast-enhanced T1-weighted imaging showed 13 of 19 HCCs with an overall sensitivity of 68.4% (13 of 19) and specificity of 65.7% (23 of 35). The sensitivity and specificity for detection of dysplastic nodules (sensitivity, 9%; specificity, 68.4%) and HCCs (sensitivity, 68.4%; specificity, 65.7%) were nearly identical for T1-weighted images read alone or read with T2 weighted images. They concluded that Contrast-enhanced T1-weighted imaging can be used as a standalone sequence for the diagnosis of HCC in patients with cirrhosis prior to liver transplantation.

Corinne [8] retrospectively reviewed MR images in 36 patients with HCC He found that lesions in cirrhotic livers differed significantly from those in non cirrhotic livers in terms of size (22 cm2 vs. 99 cm2, $P < .05$), frequency of a solitary lesion (27% vs. 72%, $P < .05$), and frequency of a central scar (6% vs 50%, $P < .05$). There was no difference between the cirrhotic and non cirrhotic livers with regard to tumor margin, intra tumoral high signal intensity on T1-weighted images, or tumor capsule.

6. Conclusion

1) In this study 60 patients who presented with focal liver lesions 52 lesions were characterized by plain and post contrast MRI specificity of 86.2%.
2) Range of the age was 22-80 yrs with sex ratio of male: female, 1.5:1.
3) The benign liver lesions, 21 of 34 (61.7%) were predominantly distributed in the age group of 21-40 yr, however malignant liver lesions 17 of 26 (65.3%) are seen to distribute in 41-60yr.
4) The most common malignant lesion studied was metastasis 15 of 26 (57.7%) and most common benign lesion studied was hemangioma 11 of 34 (32.3%).
5) The most characteristic findings of HCC being hyperintensity on T2WI (70% hyperintense and 30 % iso-hyperintense) and arterial enhancement with rapid wash out in venous and delayed phase with peripheral capsule.
6) Early peripheral enhancement in arterial phase with delayed centripetal enhancement is the characteristic imaging finding in cholangiocellular carcinoma and it could be associated with intrahepatic biliary radicles dilatation as in our study.
7) The metastatic lesions were accurately characterized in patients of known extrahepatic primary malignancy. Most common pattern was hypovascular on dynamic gadolinium enhanced imaging (DGEI).
8) The characteristic imaging finding in hemagioma is peripheral discontinuous nodular enhancement in arterial phase with progressive centripetal filling in subsequent phases, which is documented in 61% of the patients in our study.

MRI is currently considered to be the most accurate non invasive method in the evaluation of liver lesions. Plain and contrast enhanced MR imaging is excellent for the evaluation of various focal hepatic lesions. A comprehensive MR imaging examination in this setting includes T2-weighted, T1 weighted and chemical shift T1-weighted imaging and yields characteristic enhancement patterns that can be used to diagnose or at least narrow the differential diagnosis for most of these lesions which helps in the proper management of the patients.

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