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Original research article

Magnetic resonance imaging evaluation of focal liver lesions with histopathological correlation

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Abstract

It has been noticed that there has been an increase in the number of incidentally identified focal liver lesions (FLL) as a result of the proliferation of cross-sectional imaging. It is essential for effective patient treatment to have a detection and characterisation method that can be relied upon for FLL. In the context of FLL, achieving the highest possible level of imaging accuracy is of the utmost importance for preventing the performance of unneeded biopsies, which can lead to post-procedural problems. Over the past few years, there has been a significant increase in the development of innovative imaging techniques. These days, magnetic resonance imaging (MRI) plays a crucial part in the therapy of liver lesions. This imaging modality employs a technique that does not include the use of radiation, and its contrast agent profile is safe. The correct non-invasive characterisation of FLL is made possible in large part by the use of MRI. The magnetic resonance imaging (MRI) technique has the potential to deliver diagnostic information that is both extensive and extremely accurate, with the added benefit of not utilising any potentially dangerous ionising radiation. Due to these characteristics, magnetic resonance imaging has become the method of choice for the noninvasive evaluation of localised liver lesions. In this study, we address the role of hepatocyte-specific contrast agents and review the state-of-the-art MRI liver protocol. We also briefly discuss the various sequence types, the special characteristics of imaging patients who are not cooperative. In this article, a review of the imaging characteristics of the most common benign and malignant FLLs is offered, and it is accompanied with a diagrammatic portrayal of a straightforward practical method using MRI.

Keywords: Malignant, benign, magnetic resonance, focal liver lesions, hepatobiliary contrast agents

Introduction

The metabolism of amino acids, carbohydrates, and lipids as well as the production of proteins involve the liver in a number of intricate yet crucial processes [1]. When one of these metabolic routes fails, parenchymal illness typically exhibits its basic pathophysiology. Parenchymal lesions can be localised or widespread, and a focal lesion might originate from another part of the body or spread there [2-4]. The lesions or growths on or in the liver are referred to as liver lesions or hepatic lesions. Both benign and malignant tumours are possible. Malignant liver lesions are less frequent than benign ones. The most typical benign liver tumour, the haemangioma, is one of the benign tumours [5-7]. The second most common benign tumour is focal nodular hyperplasia, which also includes hepatic adenomas, angiomyolipoma, and bile duct cyst adenomas. The majority of malignant liver lesions are metastases from other cancers, most commonly those of the gastrointestinal tract (such as colon cancer, carcinoid tumours mostly of the appendix, etc.), breast, ovarian, lung, renal, prostate, etc. Hepatocellular carcinoma, cholangiocarcinoma, mixed hepatocellular and cholangiocarcinoma, hepatoblastoma, bile duct cystadenocarcinoma, fibrolamellar carcinoma, and tumours of mesenchymal tissue are the most common malignant primary liver cancers [8-10]. The most common malignant tumour in children is hepatoblastoma. Due to its low cost and accessibility, ultrasonography (USG) is still the preferred first-line imaging technique. The non-specificity of clinical signs and symptoms in liver illnesses means that clinical decision-making is typically guided by the results of an initial ultrasonography examination [11]. Ultrasonography's capabilities have been enhanced by colour Doppler flow imaging (CDFI), which enables the assessment of blood flow and perfusion. It enables the simultaneous real-time display of flow information from vessels inside the scan and high quality grayscale images of tissue. The sonologist may identify the type of lesion with a great deal more accuracy thanks to CDFI's assistance in differentiating blood flow patterns within and around hepatic tumours [12]. However, CDFI is less successful at detecting

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flow at slow speeds in the pathologic vessels' microvasculature. Instead of encoding the mean frequency of the Doppler signals, power doppler does so. Power Doppler is more accurate for displaying small tumour arteries and slow-moving blood vessels. The development of helical or spiral CT scanning has been a significant advancement in hepatobiliary imaging. True volumetric CT data can be acquired more quickly using helical (spiral) CT than with a standard scanner. Three significant technical advancements—the creation of the slip ring gantry, increased detector effectiveness, and enhanced tube cooling capability—have made routine helical CT of the abdomen conceivable [13]. With its accelerated speed and narrow slice collimation, MDCT, a recent development in CT technology, has opened up a new dimension of improved spatial and temporal resolution. It combines the ability to gather multiphase data with a quick scan time. Spiral CT increases lesion detection when compared to portal phase alone because it can identify vascular perfusion in arterial, portovenous, and delayed phases, which aids in the characterization of focal hepatic lesions [14]. In the clinical environment, focal hepatic lesions provide a daily problem. Noninvasive techniques, however, might be useful in identifying and characterising these lesions [15]. Transabdominal sonography, CECT, and MRI are frequently used to make a noninvasive diagnosis of liver abnormalities. For the evaluation of various localised hepatic lesions, dynamic three-dimensional gradient-recalled-echo MR imaging offers dynamic contrast-enhanced thin-section images with fat saturation and a high signal-to-noise ratio. The majority of these lesions can be diagnosed with a thorough MR imaging evaluation that includes T2-weighted and chemical shift T1-weighted imaging and exhibits recognisable enhancement patterns. These enhancement patterns—which 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—appear during specific periods of contrast-enhanced imaging. Therefore, becoming familiar with these enhanced patterns can help in identifying particular localised lesions of the liver. Magnetic resonance venography, magnetic resonance cholangiopancreatography, and magnetic resonance angiography (MRCP). There is also the option of biochemical imaging using MR spectroscopy. With the help of contemporary scanners and procedures, the objective of a thorough, non-invasive evaluation of the liver has been achieved and is now widely available. The best imaging technique for spotting liver lesions has been hotly contested for the past 20 years. MRI can now scan the liver thoroughly and noninvasively thanks to advancements in hardware, MR method, and contrast agents. For proper care of liver lesions, the radiologist needs a thorough understanding of modern MRI techniques [15-17].

Materials and Methods

Source of data: Patients with clinical, biochemical, ultrasound and CT evidence of liver pathology who were referred to the department of Radio diagnosis, GGH Kurnool for diagnosis.

Method of collection of data

Study design: Prospective study.
Study Place: Department of Radio- diagnosis and imaging, KMC
Study duration: Nov 2019 to Nov 2021
Sample size: Initially a minimum of 50 cases are taken up, however the scope of increasing the number of cases exists depending upon the availability within the study period.

Inclusion criteria

Patients presenting with focal hepatic lesions was suspected clinically (positive symptoms/ deranged LFT). Patients who had hepatic abnormalities on earlier imaging studies Patients who are otherwise healthy yet have abnormal hepatic imaging etc. Patients with indeterminate liver lesions detected on USG or CT.

Exclusion criteria

All patients having cardiac pacemakers, prosthetic heart valves, cochlear implants or any metallic implants. Patient having history of claustrophobia. All patients who do not consent to be a part of the study. Renal dysfunction (eGFR < 40ml/ min/1.73^2) stage 4 & 5 CKD.

Details of imaging techniques used:

All enrolled patients will be subjected to: Through history taking and physical examination. Patient was placed in proper position and Sonography of abdomen was done in GE Versana Balance equipment using convex transducer (2-5MHz). The broad band linear transducer (3-12MHz) was used whenever necessary. In all studies MR imaging was performed on Philips ingenia with dsteram technology 1.5T MRI machine. A dedicated phasedarray body coil was used.

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.

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Portal venous phase or early hepatic venous phase: 45-60 seconds after the initiation of contras 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 was considered.

Pathology Tissue diagnosis: FNAC/ Biopsy specimens were acquired and processed using a 10ml syringe, a 22 gauge spinal needle with stylet/18G true cut biopsy needle, a slide, an alcohol bottle, formalin IV, and sterile gloves. The procedures were carried out under local anaesthetic with the use of imaging. In case of patients with hemangiomas and simple cysts either follow up (average 7.5 months) or post-surgical histopathology has been considered. Data and various findings seen in MRI scan collected and results were tabulated. Then compared with the final diagnosis made onsurgery/biopsy/FNAC /aspiration or by therapeutic follow up and the relevant statistical analysis was done.

Statistical analysis: Sensitivity, specificity, Positive predictive value and negative predictive value applicable

Observations and Results

The present study was conducted in the Department of Radio diagnosis GGH, Medical College. The study population comprised of all the patients with suspicion of hepatic masses on clinical and/or Ultrasonography findings. A total of 50 cases with hepatic lesions were evaluated using MRI. The distribution of cases is depicted in the following table:

Table 1: Distribution of cases

Lesion	Number of Patients	%
Benign Focaliver Lesions		
Haemangioma	7	14
Hydatid cyst	6	12
Abscess	6	12
Simple hepatic cyst	3	6
Focal fatty infiltration	2	4
Hepatic adenoma	1	2
Poly cystic liver disease	1	2
Kochs granuloma	1	2
Biliary hamartoma	1	2
Regenerative nodule	1	2
Malignant Focaliver Lesions		
Metastases	10	20
Hepatocellular carcinoma	7	14
Cholangio carcinoma	3	6
Lymohoma	1	2
Total	50	100

Out of 50 cases, there were a total of 29 benign and 21 malignant masses. Most common benign hepatic tumour was hemangiomas while Metastases was most common malignant hepatic tumour.

Table 2: Age distribution of patients with focal liver lesions

Age distribution (years)	Number of patients	%
<20	1	2
21-30	3	6
31-40	7	14
41-50	10	20
51-60	18	36

ISSN:0975 -3583,0976-2833 VOL13, ISSUE 05, 2022

>60	11	22
Total	50	100

The age range of cases varied from 2 years to 70yrs with the more number of patients was between ages of 51 and 60yrs (36%).

Table 3: Age distribution in hepatic lesions

Lesion	Number of Cases	Age group (In Years)					
Benign lesions		**<20**	**21-30**	**31-40**	**41-50**	**51-60**	**>60**
Haemangioma	7	-	1	1	2	2	1
Hydatid cyst	6	-	1	1	1	2	1
Abscess	6	-	-	-	4	1	1
Simple hepatic cyst	3	-	-	-	-	1	2
Focal fatty infiltration	2	-	-	2	-	-	
Hepatic adenoma	1	-	-	1	-	-	
Polycystic liver disease	1	-	-	-	-	-	1
Kochs granuloma	1	1	-	-	-	-	
Biliary hamartoma	1	-	-	1	-	-	
Regenerative nodule	1	-	-	-	1	-	
Malignant Lesions							
Metastases	10	-	1	1	-	5	3
Hepatocellular carcinoma	7	-	-	-	1	5	1
Cholangio carcinoma	3	-	-	-		2	1
Lymohoma	1	-	-	-	1	-	
Total	50	1	3	7	10	18	11

The table reveals that 36% of the cases were observed in the sixth decades of life.
HCC and metastases were predominantly seen in patients aged more than 40 yrs. Metastases were seen in 10 (20%) cases and majority of cases were in sixth and seventh decade of life. HCC were seen in 7 (14%) cases out of total 50 cases. Out of 7 cases of HCC, 5(71.42%) cases were seen in51-60 age group.7 cases of hemangioma were seen, out of which 4 (57.14%) were in fifth and sixth decade of life. Cholangiocarcinoma were seen in 3 cases out of which 2(66.66%) cases were in 51-60y of age group.

Table 4: Sex distribution in patients with focal liver lesions

Gender	Number of patients	%
Male	33	66
Female	17	17

The above table shows that 66% of the cases included in the study were males and 17% were females.

Table 5: Sex distribution in patients with benign focal liver lesions

Gender	Number of patients	%
Male	17	58
Female	1	41

Table 6: Sex distribution in patients with malignant focal liver lesions

Gender	Number of patients	%
Male	16	76.2
Female	05	23.8

Table 7: Clinical features in hepatic lesions

Final diagnosis	Number of Cases	Alcohol l	Pain	Abd mass	Weight loss	Jaundice
Focal Fatty infiltration	2	-	1	-	-	-
Simple hepatic cyst	3	1	2	1	-	-
Liver abscess	6	1	5	1	-	-
Tuberculosis	1	-	1	-	-	-
Haemangioma	7	-	6	2	-	-
Regenerative nodule	1	1	1	-	-	1
Cholangiocarcinoma	3	1	3	2	2	2
Lymphoma	1	-	1	-	-	-
HCC	7	4	5	4	3	4
Hepatic adenoma	1	-	1	-	-	1
Biliary hamartoma	1	-	1	_	_	1
Hydatid cyst	6	2	5	4	-	2

ISSN:0975 -3583,0976-2833 VOL13, ISSUE 05, 2022

Poly cystic liver disease	1	-	1	-	-	-
Metastasis	10	1	7	1	7	4
Total	50	11	41	16	15	15

*One patient may have more than one symptom

Most common symptom in the cases presenting with hepatic masses was pain abdomen (82%) with abdominal mass being the second most common symptom (32%). Pain abdomen was the most common symptom in the cases of haemangioma (85.71%). Pain abdomen was the most common symptom in the cases of HCC (71.45%).4 (57.14%) out of 7cases of HCC were alcoholic. Pain and Weight loss were the most prevalent symptoms in metastases (70%).

Table 8: Radiological vs clinical diagnosis

Final Diagnosis	Number of Cases	Clinical Diagnosis	
		Same	Different
Focal Fatty infiltration	2	-	1(Hepatitis) 1(liver abscess)
Simple hepatic Cyst	3	-	2(incidental) 1(COL)
Liver abscess	6	3	1(Hydatid cyst) 2(Cholelithiasis)
Kochs granuloma	1	1	-
Haemangioma	7	-	3(APD) 4(incidental)
Regenerative nodule	1	-	1(Liver Abscess)
Cholangiocarcinoma	3	1	2(HCC)
Hepatocellular carcinoma	7	4	2(Cholangio carcinoma) 1(COL)
Metastases	10	6	2(HCC) 2(COL)
Biliary hamartoma	1	-	1(PCLD)
Lymphoma	1	1	-
Hydatid cyst	6	2	2(Liver abscees) 2(Cholelithiasis)
Hepatic adenoma	1	-	1(Cholelithiasis)
Poly cystic liver disease	1	1	-
Total	50	19	31

The clinical diagnosis was in agreement with final diagnosis in 38% of the cases. 57.14% of HCC were correctly diagnosed clinically. 60% of cases with metastases were correctly suspected clinically. None of the cases with haemangioma, focal fatty infiltration, and simple hepatic cyst were correctly diagnosed clinically. All the cases of HCC diagnosed correctly were based on clinical findings and raised AFP levels.

Table 9: Number distribution in hepatic lesions

	Number of patients	%
Single	27	54
Multiple	23	46

Table 10: Number Distribution in Benign Hepatic Lesions

	Number of patients	%
Single	18	62.1
Multiple	11	37.9

Table 11: Number distribution in malignant hepatic lesions

	Number of Patients	%
Single	09	42.8
Multiple	12	57.2

Table 12: Classification of Focal Hepatic Lesions

Classification of Diseases	
Classification	Number of cases
Neoplasm	30
Infection	13
Congenital	5
Pseudo lesion	2

Table 13: USG appearance of the hepatic lesions

Appearance of lesions	Number of patients
Anechoic with peripheral calcification	4
Heterogenous	23

ISSN:0975 -3583,0976-2833 VOL13, ISSUE 05, 2022

Hyperechoic	9
Hypoechoic	7
Anechoic	7

Table 14: Appearance of all lesions on t1w

T1 inphase /outphase	Number of patients	%
Low signal intensity	37	74
ISO to liver parenchyma	1	2
High signal intensity	2	2
Mixed signal intensity	11	22

Table 15: Final diagnosis (pathological confirmation) vs radiological diagnosis

Radiological diagnosis	Number of Cases	Final diagnosis (pathological confirmation)	
		Same	Different
Focal Fatty infiltration	2	2	_
Simple Cyst	3	3	_
Liver abscess	6	6	-
Kochs granuloma	1	1	-
Haemangioma	7	7	-
Regenerative nodule	1	1	-
Cholangiocarcinoma	3	3	-
Hydatid cyst	6	6	
Poly cystic liver disese	1	1	
Bilary hamartoma	1	1	
Hepatocellular carcinoma	7	5	1(Metastases) 1(cholangio carcinoma)
Hepatic adenoma	1	1	_
Lymphoma	1	-	Kochs granuloma
Metastases	10	9	1(Regenerative nodule)
Total	50	46(92%)	4(8%)

Table 16: Statistical indices of benign lesions

Positive	
True positive	29
False positive	0
Negative	
False negative	2
True negative	19
Output	
Sensitivity	93.55%
Specificity	100%
Positive predictive value	100%
Negative predictive value	93.94%

Table 17: Statistical indices of malignant lesions

Positive	
True positive	19
False positive	2
Negative	
False negative	0
True negative	29
Output	
Sensitivity	100%
Specificity	93.55%
Positive predictive value	93.94%
Negative predictive value	100%

Table 18: Overall sensitivity

	MRI
Cases with correct diagnosis (true positive)	46
Incorrect diagnosis	4
Diagnostic accuracy	92%

Overall Sensitivity of MRI was 92%.

ISSN:0975 -3583,0976-2833 VOL13, ISSUE 05, 2022

Discussion

The current study was carried out at the GGH, Kurnool Medical College's Department of Radio diagnosis. The study population included patients who had been sent to the department of Radio-diagnostic and imaging at Kurnool Medical College and GGH for diagnosis and had clinical, biochemical, ultrasound, and CT evidence of liver pathology. The study period was from November 2019 to November 2021. Out of 61 patients who were referred by different clinical departments, 4 metastasis patients had advanced cases and were given chemotherapy for palliation; 3 metastasis patients passed away before FNAC could be performed; and 4 patients who were suspected of having HCC were lost to follow-up and FNAC could not be done. 50 instances in total were thus included in the study [18]. 50 patients with localised hepatic lesions were included in this investigation. There were 17 women and 33 (66%) men in the study group. The majority of the patients (57%) belonged to the 31–60 age range. In the current study, 42% of the lesions were cancerous. Metastases, which were found in 20% of cases and were present in 8 patients (80%) or older, were the most common malignant primary hepatic neoplasm investigated. Matsui *et al*. (2005) and Silverman *et al*. (2005) both found similar findings (2009). In situations where hepatic masses were present, abdominal pain was most frequently reported (82%) followed by abdominal mass (32%). The two symptoms that metastases have in common the most were pain and weight loss (70%). The most prevalent HCC symptom was abdominal pain (71.42%). Hepatomegaly or a mass felt in the right hypochondrium (36% of patients) was the most common clinical symptom. These were listed as typical clinical characteristics associated with hepatobiliary disease by Saini *et al*. in 1997. In 38% of cases, an appropriate diagnosis could be made just from the clinical profile. Below is an explanation of how imaging aids in the diagnosis, identification, and delineation of various lesions.

Conclusions

A total of 50 individuals with hepatic lesions ranging in age from 2 to 70 years were examined, with a maximum of 36% in the 51 to 60 year age group. Males made up 66% of the patients, with a 2:1 male to female ratio. There were 40% non-tumorous hepatic mass lesions, 18% benign hepatic tumours, and 42% malignant lesions. In our series, metastatic disease accounted for 20% of all patients. With 47.61% of all malignant cases, it was also the most common malignant lesion. For malignant mass lesions, MRI has 100% sensitivity and 93.55% specificity, and it has 93.55% sensitivity and 100% specificity for benign diseases. On Doppler, a simple cyst is shown as a well-defined anechoic lesion with posterior enhancement but no vascularity. The results of the USG and CT scans can be used to confirm the diagnosis; however, the use of several MRI sequences provided additional details about the cyst's interior composition. The pathognomic features of hydatid sand and floating membrane can be used to validate the diagnosis of hydatid cyst on the USG itself. On T1W and T2W images of the MRI, a low intensity rim was seen to surround the lesion, which is a particular finding. It is frequently easy to distinguish between amoebic and pyogenic abscess using sonography. Amoebic abscesses are often single, clearly defined, hypoechoic, and enhanced posteriorly. Perilesional edoema was discovered on an MRI to be exclusive to an amoebic liver abscess. On USG, hemangiomas appear well-defined and hyperechoic in small lesions, however lesions larger than 6 cm in size may have a heterogeneous pattern. On T1w pictures of the MR, there is a low signal intensity, but on T2w imaging, there is a very high signal intensity and, characteristically, there is peripheral nodular enhancement with delayed centripetal filling. Because haemangiomas are bright on T2WI, MRI proved particularly effective in separating tiny lesions from small HCC. As a result, MR data are considered to be diagnostic. MRI is useful in separating benign nodules from dysplastic nodules, which may exhibit malignant HCC focus. HCC manifests as a solid heteroechoic lesion with ill-defined borders and diffuse vascularity. On USG, metastatic lesions had a diverse appearance. The most typical sonographic pattern showed several, clearly defined, solid hypoechoic liver lesions. The underlying tumor's primary vascularity is reflected in the vascularity of the metastatic lesions. In contrast to HCCs, which have a diffuse pattern of vascularity, hypervascular metastasis has a peripheral pattern. The results of the MR scan are vague. On USG, focal fatty infiltration cannot be distinguished from hepatic lesions; however, MRI can do so. For hepatic lesions, ultrasonography is a helpful screening method. Ultrasonography should be used on all individuals who have hepatic lesions suspected in order to initially identify and localise the lesion. MRI, which has a sensitivity of 92%, is a reliable diagnostic method for identifying hepatic masses. The results of this study demonstrate the benefits of using multiplanar imaging and MRI with significant soft tissue contrast for the detection and characterization of a range of hepatic pathologies. When a patient is suspected of having a hepatic lesion, it is advised that US be performed as the initial screening method. CT and MRI should then be utilised to further characterize the lesion and stage any malignant lesions.

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