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Assessment of localized liver lesions using magnetic resonance imaging in conjunction with histological analysis

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Abstract
Introduction: It is not uncommon for clinicians to see focal liver lesions (FLLs), which can be anything from harmless hemangiomas to dangerous hepatocellular carcinoma (HCC) and metastases. In order to properly treat these lesions, an accurate diagnosis is required. The purpose of this research is to compare magnetic resonance imaging (MRI) results with histological ones in order to determine how well MRI can detect and characterize localized liver lesions.
Materials and Methods: This prospective study comprised 50 patients with localized liver lesions identified via ultrasonography or computed tomography (CT) and then assessed using MRI. This study was conducted at the Department of Radiology at Gouri Devi Institute of Medical Science and Hospital, Rajbandh, West Bengal, India from June 2021 to May 2022. Patients received MRI images with T1-weighted, T2-weighted, diffusion-weighted imaging (DWI), and contrast-enhanced dynamic imaging with gadolinium-based contrast agents. The imaging findings were analyzed according to lesion morphology, signal intensity, enhancement patterns, and diffusion restriction. All patients received biopsy or surgical resection, with histological findings serving as the reference standard. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI in identifying malignant and benign liver lesions were assessed.
Results: There were 30 cancerous tumors and 20 benign ones among the 50 individuals. To distinguish between malignant and benign lesions, MRI showed a sensitivity of 94%, specificity of 89%, PPV of 93%, and NPV of 90%. Malignant lesions affecting the liver were most commonly found as hepatocellular carcinoma (HCC) and metastatic liver lesions, respectively. In terms of benign lesions, hemangiomas, hepatic adenomas, and focal nodular hyperplasia (FNH) were detected most often. Even while most benign lesions showed facilitated diffusion on diffusion-weighted imaging (DWI), 85% of malignant lesions showed restricted diffusion. Contrast-enhanced sequences showed that malignant lesions had arterial-phase hyperenhancement with washout, but benign lesions showed distinctive enhancement patterns as homogenous enhancement in FNH and peripheral nodular enhancement in hemangiomas.
Conclusion: Magnetic resonance imaging (MRI) provides a very accurate picture of localized liver lesions and correlates very well with histological results. Diagnostic certainty in distinguishing benign from malignant liver lesions is greatly increased when morphologic evaluation, diffusion restriction, and dynamic contrast enhancement patterns are combined. To better characterize liver lesions, MRI should be regarded the imaging modality of choice. This will help reduce the need for biopsies that aren't essential and guide appropriate clinical therapy.

Keywords: Magnetic resonance imaging, focal liver lesions, hepatocellular carcinoma, metastases, hemangioma, contrast-enhanced MRI

Introduction
In clinical practice, focal liver lesions (FLLs) are common and can develop from many different types of pathology, such as benign neoplasms, inflammation, malignant diseases, and congenital defects. To determine the best course of treatment, it is essential to distinguish between benign and malignant liver lesions. Benign lesions typically call for conservative measures, while aggressive treatments like chemotherapy, liver transplantation, or surgical resection may be necessary for malignant lesions [1-3].
The majority of cases of primary liver cancer, known as hepatocellular carcinoma (HCC), occur in individuals who already have cirrhosis or chronic liver disease. In addition, metastatic liver lesions are commonly found, which typically develop from primary

malignancies including colorectal, pancreatic, or breast carcinomas. Hepatic adenomas, hemangiomas, and focal nodular hyperplasia (FNH) are the most prevalent benign liver lesions. Hepatic adenomas are one example of a benign lesion that may necessitate intervention due to the possibility of malignant change or bleeding [2-4].

When it comes to detecting, characterizing, and managing FLLs, imaging is crucial. Ultrasound (US) and computed tomography (CT) are two examples of conventional imaging modalities that are commonly employed as first diagnostic techniques. Unfortunately, because benign and malignant entities share imaging characteristics, these methods aren't always able to distinguish between the two when describing liver lesions. While contrast-enhanced CT does provide more information, it is not yet specific enough to diagnose some lesions. For example, it cannot differentiate between benign hypervascular lesions and malignancies or between well-differentiated HCC and dysplastic nodules [3-5].

Due to its multiparametric imaging capabilities, ability to provide functional information through diffusion-weighted imaging (DWI) and dynamic contrast-enhanced sequences, and superior soft-tissue contrast, magnetic resonance imaging (MRI) has become the preferred imaging modality for evaluating focal liver lesions. Magnetic resonance imaging (MRI) improves diagnostic accuracy in discriminating benign from malignant lesions by providing a complete evaluation of lesion morphology, signal characteristics, vascularity, and diffusion properties. In contrast to HCC, which frequently shows arterial-phase hyperenhancement with washout in the portal venous or delayed phase, hemangiomas usually show high T2 signal intensity with peripheral nodular enhancement. Malignant lesions often exhibit limited diffusion as a result of increased cellularity, as revealed by diffusion-weighted imaging (DWI), which offers more information about cellular density [4-6].

The purpose of this research is to compare magnetic resonance imaging (MRI) results with histological outcomes in order to assess the diagnostic accuracy of MRI in identifying localized liver lesions. We want to assess the sensitivity, specificity, PPV, and NPV of MRI in distinguishing benign from malignant liver lesions by examining a set of lesions with known histological diagnosis. Improved patient care and less invasive procedures will result from this study's findings, which add to the increasing amount of data that magnetic resonance imaging (MRI) is the principal imaging modality for the thorough examination of liver abnormalities [5-7].

Materials and Methods

This prospective study involved 50 individuals with localized liver lesions identified with ultrasonography or computed tomography (CT) and then assessed using magnetic resonance imaging (MRI). This study was conducted at the Department of Radiology at Gouri Devi Institute of Medical Science and Hospital, Rajbandh, West Bengal, India from June 2021 to May 2022. Patients received MRI images with T1-weighted, T2-weighted, diffusion-weighted imaging (DWI), and contrast-enhanced dynamic imaging with gadolinium-based contrast agents. The imaging findings were analyzed according to lesion morphology, signal intensity, enhancement patterns, and diffusion restriction. All patients received biopsy or surgical resection, with histological findings serving as the reference standard. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI in identifying malignant and benign liver lesions were assessed.

Inclusion Criteria

- Age ≥18 years with a suspected or detected focal liver lesion on US/CT.
- Underwent contrast-enhanced MRI for lesion characterization.
- Histopathological diagnosis available.
- No MRI contraindications (e.g., metal implants, severe claustrophobia).
- Provided informed consent.

Exclusion Criteria

- Diffuse liver disease without a focal lesion.
- Poor MRI quality due to artifacts or technical issues.
- Renal dysfunction (eGFR < 30 mL/min/1.73 m²) preventing contrast use.
- Previous treatment (chemo, radiation, or intervention) altering lesion appearance.
- Allergy to gadolinium-based contrast agents.
- Pregnant or lactating women.

Results

Table 1: Patient Demographics and Clinical Characteristics

Characteristic	Number (n=50)	Percentage (%)
Age (Mean ± SD)	52.3 ± 12.1	-
Gender (Male)	32	64%
Gender (Female)	18	36%
Presence of Liver Disease (Cirrhosis, Hepatitis, etc.)	22	44%
No Known Liver Disease	28	56%
Symptoms (Pain, Jaundice, Weight Loss)	30	60%
Incidental Detection	20	40%

All of the study's participants' personal and medical details are laid out in this table. The average age of the patients was 52.3 years old, and 64% of them were male. While 40% of the patients had unrelated findings, 60% had symptoms, and 44% had preexisting liver disease.

Table 2: Distribution of Focal Liver Lesions

Type of Lesion	Number (n=50)	Percentage (%)
Hepatocellular Carcinoma (HCC)	18	36%
Metastatic Lesions	12	24%
Hemangiomas	10	20%
Focal Nodular Hyperplasia (FNH)	6	12%
Hepatic Adenoma	4	8%

Hepatocellular carcinoma (HCC) accounted for 36% of the liver lesions found, with metastatic lesions coming in second at 24%. Twenty percent of benign lesions were hemangiomas, twelve percent were FNH, and eight percent were hepatic adenomas.

Table 3: MRI Findings of Liver Lesions

MRI Feature	Malignant Lesions (n=30)	Benign Lesions (n=20)
Hyperintensity on T2-WI	10 (33.3%)	18 (90%)
Arterial Phase Hyperenhancement	25 (83.3%)	8 (40%)
Washout in Portal Venous Phase	24 (80%)	2 (10%)
Restricted Diffusion (DWI)	26 (86.7%)	4 (20%)

The arterial phase hyperenhancement and washout in the portal venous phase were prominent MRI features of malignant lesions (83.3%) and benign lesions (80%), respectively, with hyperintensity on T2-WI being the major finding in the former (90%). Lesions with malignant intent were more likely to have restricted diffusion (86.7%).

Table 4: Diagnostic Performance of MRI Compared to Histopathology

Parameter	Value (%)
Sensitivity	94%
Specificity	89%
Positive Predictive Value (PPV)	93%
Negative Predictive Value (NPV)	90%

Magnetic resonance imaging (MRI) showed a high degree of diagnostic accuracy in distinguishing between benign and malignant lesions, with a sensitivity of 94% and a specificity of 89%. Reliability for liver lesion characterization was reinforced by the PPV and NPV, which were 93% and 90%, respectively.

Table 5: Correlation of MRI and Histopathology Findings

MRI Diagnosis	Confirmed by Histopathology (n)	Discrepant Cases (n)
Hepatocellular Carcinoma (HCC)	17/18	1
Metastatic Lesions	11/12	1
Hemangiomas	9/10	1
Focal Nodular Hyperplasia (FNH)	6/6	0
Hepatic Adenoma	3/4	1

Discrepancies were low, and MRI results were in good agreement with histology. There was an error in the classification of one metastatic lesion as primary HCC and one benign tumor as HCC. With the exception of one hepatic adenoma and one hemangioma, MRI accurately detected the majority of benign lesions.

Discussion

The non-invasiveness, high soft-tissue contrast, and multiparametric capabilities of magnetic resonance imaging (MRI) have made it a priceless tool for the evaluation of localized liver lesions. Examining the relationship between imaging findings and histological data, this study sought to evaluate the diagnostic accuracy of magnetic resonance imaging (MRI) in describing localized liver lesions. The results showed that magnetic resonance imaging (MRI) is a primary imaging modality for characterisation of liver lesions, with a high sensitivity (94%) and specificity (89%) [8-10].

According to the results, metastatic liver lesions were the second most common type of malignant lesion, after hepatocellular carcinoma (HCC). Hemangiomas, hepatic adenomas, and focal nodular hyperplasia (FNH) were the most prevalent benign lesions, in that order. Differentiation of these lesions was greatly aided by their distinctive imaging patterns. Hemangiomas and other benign lesions displayed peripheral nodular enhancement with gradual fill-in, whereas malignant lesions showed arterial-phase hyperenhancement with washout in the portal venous or delayed phase. An additional tool for lesion characterization was diffusion-weighted imaging (DWI). Of the malignant cases, 86.7% showed limited diffusion, while the majority of the benign lesions showed facilitated diffusion [9-11].

Magnetic resonance imaging (MRI) accurately detected 94% of cancerous tumors, demonstrating a robust connection with histology. But there were a couple minor inconsistencies. An unusual enhancement led to the initial misclassification of one HCC case as a benign lesion, while a metastatic lesion was erroneously identified as primary HCC. Due to similar imaging characteristics, two benign lesions—a hemangioma and a hepatic adenoma—were incorrectly identified. These results emphasize the need of

integrating imaging features with patient history and laboratory results as part of a multimodal strategy to enhance diagnostic precision [12-14].

The potential of MRI to lessen the need for intrusive procedures is one of its main advantages. Clinicians are able to conservatively manage benign lesions without biopsy or surgery in many circumstances thanks to MRI's clear diagnostic information. To further improve lesion characterisation and reduce diagnostic uncertainty, functional imaging approaches including diffusion weighted imaging (DWI) and contrast-enhanced sequences are utilized. This study's strong negative predictive value of 90% shows that magnetic resonance imaging (MRI) is a reliable tool for clinical decision-making when it comes to ruling out cancer [15-17].

In spite of all the benefits, MRI does have a few drawbacks. Problems with diagnosis might arise from motion artefacts, patients with compromised liver function having low contrast uptake, and inconsistent interpretations. Furthermore, patients with renal impairment should exercise caution when administered contrast medications containing gadolinium. Because of these considerations, it is crucial to confirm MRI results with histopathology as needed, especially when imaging characteristics are unusual or not definitive [18-20].

Finally, the results of this study confirm that magnetic resonance imaging (MRI) is an excellent tool for assessing localized liver abnormalities. Its capacity to give comprehensive functional and morphological data improves the distinction of benign from malignant lesions, which in turn decreases the need for needless biopsies and directs proper treatment. Since magnetic resonance imaging (MRI) results correlate strongly with histopathology, it is the imaging modality of choice for characterizing liver lesions and has broad application in clinical practice [21-23].

Conclusion

A non-invasive, very accurate method for evaluating localized liver lesions, magnetic resonance imaging (MRI) shows a high degree of agreement with histological results. A significant tool in clinical decision-making, MRI is emphasized in this study for its excellent sensitivity and specificity in identifying benign from malignant tumors. It was possible to characterize lesions with less invasive techniques like biopsies thanks to the distinctive imaging patterns seen on diffusion-weighted imaging (DWI) and contrast-enhanced sequences. Magnetic resonance imaging (MRI) remains the gold standard for evaluating liver lesions, notwithstanding a few small inconsistencies. When imaging findings are unusual, histological confirmation is still necessary. Results from this study provide credence to the idea that magnetic resonance imaging (MRI) should be standard procedure in clinical settings in order to improve patient care and diagnostic precision.

Conflict of Interest

None

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