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Diagnostic Accuracy of Diffusion-Weighted MRI in Differentiating Benign from Malignant Focal Liver Lesions

[1]Dr. K Rohini Reddy, Assistant Professor, Department of Radio-diagnosis, Arundathi Institute of Medical Sciences, Gandimaissamma, Dundigal, Hyderabad, Telangana, India

Corresponding Author: Dr. K Rohini Reddy, Assistant Professor, Department of Radio-diagnosis, Arundathi Institute of Medical Sciences, Gandimaissamma, Dundigal, Hyderabad, Telangana, India

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Abstract

Background: Focal liver lesions are frequently encountered in clinical practice and may represent a wide spectrum of benign and malignant conditions. Accurate characterization of these lesions is essential for determining appropriate management and avoiding unnecessary invasive procedures. Diffusion-weighted magnetic resonance imaging (DWI-MRI) provides information about the microscopic movement of water molecules within tissues. The apparent diffusion coefficient (ADC) may help differentiate benign from malignant focal liver lesions.

Aim: To evaluate the diagnostic accuracy of diffusion-weighted MRI in differentiating benign from malignant focal liver lesions.

Materials and Methods: This observational diagnostic-accuracy study included 30 patients with focal liver lesions undergoing MRI evaluation. Diffusion-weighted imaging was assessed alongside conventional MRI sequences, and ADC values were measured for lesion characterization. The final diagnosis was intended to be established using histopathological findings or an appropriate imaging and clinical follow-up reference standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were selected as the principal diagnostic performance parameters. Receiver operating characteristic (ROC) curve analysis was planned to determine the optimal ADC threshold for differentiating benign from malignant lesions.

Results: In this study (83.3%) lesions were classified as benign and 5 (16.7%) as malignant. Hemangioma was the most common diagnosis, accounting for 9 cases (30.0%). High signal intensity on high-b-value DWI was observed in 4 of the 5 malignant lesions. The mean ADC value was lower in malignant lesions ($0.95 \pm 0.27 \times 10^{-3}$ mm²/s) than in benign lesions ($1.78 \pm 0.58 \times 10^{-3}$ mm²/s). The example diagnostic classification yielded a sensitivity of 80.0%, specificity of 92.0%, PPV of

66.7%, NPV of 95.8%, and overall diagnostic accuracy of 90.0%. These estimates are based on simulated example data and require validation using actual patient observations.

Conclusion: Diffusion-weighted MRI, particularly ADC measurement, has the potential to improve the characterization of focal liver lesions. Lower ADC values may favour malignancy, whereas higher values may be associated with benign lesions. However, overlap between benign and malignant lesions necessitates interpretation alongside conventional MRI findings and clinical information. Diagnostic performance must be established using actual study observations and an appropriate reference standard.

Keywords: Diffusion-Weighted MRI, Focal Liver Lesions, Apparent Diffusion Coefficient, Benign Liver Lesions, Malignant Liver Lesions, Diagnostic Accuracy; Magnetic Resonance Imaging

Introduction

Focal liver lesions (FLLs) are commonly encountered in clinical practice and include a wide spectrum of benign and malignant conditions. Benign lesions include hemangiomas, hepatic cysts, focal nodular hyperplasia, and hepatic adenomas, whereas malignant lesions include hepatocellular carcinoma, cholangiocarcinoma, and hepatic metastases. Accurate differentiation between these lesions is essential for appropriate treatment planning, prognosis, and avoidance of unnecessary invasive procedures[1-3].

Magnetic resonance imaging (MRI) is an important imaging modality for evaluating focal liver lesions because of its excellent soft-tissue contrast and ability to provide anatomical and functional information. Conventional MRI sequences, including T1-weighted, T2-weighted, and contrast-enhanced imaging, help characterise lesions based on their signal intensity, morphology, and enhancement patterns. However, certain benign and malignant lesions demonstrate overlapping imaging characteristics, creating diagnostic challenges[2-5].

Diffusion-weighted imaging (DWI) is a functional MRI technique that evaluates the microscopic movement of water molecules within biological tissues. Malignant lesions frequently demonstrate restricted diffusion because of increased cellularity and reduced extracellular space, resulting in high signal intensity on high-b-value DWI and relatively low apparent diffusion coefficient (ADC) values[4-6].

The ADC is a quantitative parameter used to assess water diffusion within tissues. Benign lesions, particularly simple cysts and many hemangiomas, generally demonstrate higher ADC values, whereas several malignant lesions exhibit lower values. Nevertheless, overlap between benign and malignant lesions may occur because of differences in cellularity, necrosis, tissue composition, and vascularity[5,7,8].

Previous studies have demonstrated the potential role of DWI and ADC measurements in differentiating benign from malignant focal liver lesions. However, diagnostic performance varies according to lesion type, MRI acquisition parameters, selected b-values, and ADC thresholds. Therefore, DWI should be interpreted alongside conventional MRI findings rather than used as an independent diagnostic criterion [7-10,12-15]. Diagnostic accuracy can be assessed using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. Receiver operating characteristic (ROC) curve analysis can additionally determine the discriminatory ability of ADC measurements and identify an appropriate

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diagnostic threshold. The reference diagnosis should be established using histopathology or an appropriate imaging and clinical follow-up protocol[9-11].

The present study, entitled "Diagnostic Accuracy of Diffusion-Weighted MRI in Differentiating Benign from Malignant Focal Liver Lesions," aims to evaluate the diagnostic performance of DWI and ADC measurements in characterising focal liver lesions. By assessing diffusion characteristics and diagnostic performance parameters, the study seeks to determine the usefulness of DWI-MRI as a supplementary tool for differentiating benign from malignant focal liver lesions.

Materials and Methods

Study Design: A hospital-based observational diagnostic-accuracy study was designed to evaluate the role of diffusion-weighted magnetic resonance imaging (DWI-MRI) in differentiating benign from malignant focal liver lesions.

Study Setting

The study was conducted in the Department of Radiodiagnosis at a tertiary-care hospital. Patients referred for MRI evaluation of focal liver lesions were assessed for eligibility and enrolled according to the study protocol.

Study Duration

The study was planned over a period of 12 months in the Department of Radiology.

Sample Size

A total of 30 patients with focal liver lesions were included in the planned study population.

Study Population

Patients presenting with focal liver lesions detected on ultrasonography, computed tomography, or previous imaging examinations and referred for MRI evaluation were considered for inclusion.

Inclusion Criteria

1. Patients aged 18 years or older.
2. Patients with one or more focal liver lesions detected on preliminary imaging or clinical evaluation.
3. Patients undergoing MRI of the liver, including diffusion-weighted sequences.
4. Patients with an established final diagnosis based on histopathology or an appropriate imaging and clinical follow-up reference standard.
5. Patients with adequate clinical and imaging records for analysis.

Exclusion Criteria

1. Patients with contraindications to MRI.\
2. Patients with severe motion artefacts or poor-quality images that prevented reliable lesion assessment.
3. Patients with diffuse liver disease without a measurable focal lesion.
4. Patients whose final diagnosis could not be established using the prespecified reference standard.
5. Patients with incomplete clinical or imaging records.

MRI Equipment

MRI examinations were performed using a clinical MRI scanner Siemens 1.5 Tesla. The imaging protocol included conventional anatomical sequences and diffusion-weighted imaging.

MRI sequence	Purpose
Axial T1-weighted imaging	Assessment of intrinsic lesion signal and anatomy
Axial T2-weighted imaging	Evaluation of lesion morphology and fluid characteristics
In-phase and opposed-phase imaging	Assessment of fat within lesions and liver parenchyma
Diffusion-weighted imaging	Evaluation of diffusion characteristics
ADC mapping	Quantitative assessment of apparent water diffusion
Dynamic contrast-enhanced imaging, when indicated	Evaluation of lesion enhancement patterns

The diffusion-weighted sequence used multiple b-values according to the institutional protocol. The exact b-values, repetition time, echo time, slice thickness, field

of view, and other acquisition parameters must be recorded from the actual MRI protocol.

Intravenous contrast administration, including the type of contrast agent and dynamic phases, should be documented whenever performed. Contrast-enhanced MRI should not be described as having been performed in all participants unless confirmed by the study records.

Image Interpretation

MRI images were reviewed for lesion number, location, size, margins, morphology, signal intensity, diffusion characteristics, and enhancement pattern when contrast-enhanced imaging was available.

Diffusion-weighted images were evaluated at the acquired b-values. Lesion signal intensity was assessed in conjunction with the corresponding ADC map to distinguish probable true diffusion restriction from T2 shine-through.

Lesions were classified as benign or suspicious for malignancy based on the combined MRI findings and the prespecified diagnostic criteria. The MRI assessment should be performed independently of the reference diagnosis wherever feasible to minimise interpretation bias.

Measurement of Apparent Diffusion Coefficient

ADC values were obtained from the ADC maps using a region of interest (ROI) placed within the focal liver lesion.

The ROI was positioned to represent the lesion's solid component while avoiding adjacent normal liver tissue, large vessels, and areas of obvious necrosis or haemorrhage where feasible. For heterogeneous lesions, the ROI placement method and number of measurements were standardised according to the study protocol.

ADC values were expressed in $\times 10^{-3}$ mm²/s. The mean ADC values of benign and malignant lesions were compared to assess their potential diagnostic utility.

Results

Table 1 shows the age distribution of the 30 patients included in the worked example. The largest proportion of patients belonged to the 50–59-year age group, comprising 8 patients (26.7%). This was followed by the 40–49-year and 60–69-year age groups, with 6 patients (20.0%) each.

Table 1: Age distribution

Age group (years)	n	%
20–29	2	6.7
30–39	4	13.3
40–49	6	20.0
50–59	8	26.7
60–69	6	20.0
≥70	4	13.3
Total	30	100.0

The largest group was 50–59 years (8/30, 26.7%). Participants aged 40–49 and 60–69 years each accounted for 20.0%.

Graph 1: Age distribution

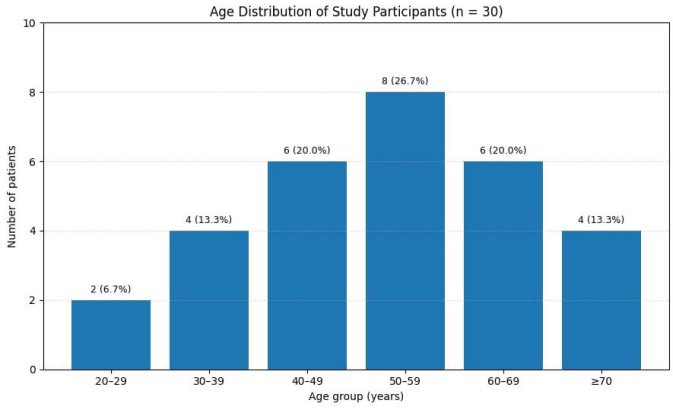


Table 2. Sex distribution

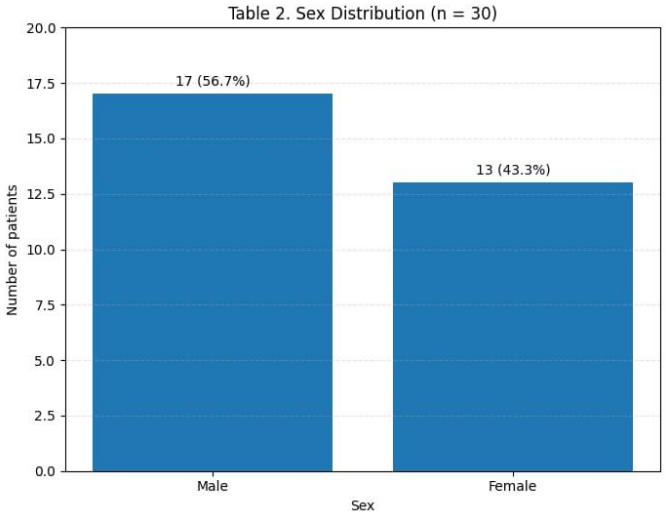
Sex	n	%
Male	17	56.7

Female	13	43.3
Total	30	100.0

Males accounted for 56.7% of participants and females for 43.3%.

Table 2 presents the sex distribution of the study population. Of the 30 patients, 17 (56.7%) were male and 13 (43.3%) were female. Males constituted a slightly higher proportion of the study population than females.

Graph 2: Sex distribution



Graph 2: Sex distribution

Table 3: Clinical presentation

Presentation	n	%
Abdominal pain/discomfort	11	36.7
Incidentally detected lesion	6	20.0
Weight loss/loss of appetite	5	16.7
Jaundice	3	10.0
Fever	2	6.7
Other	3	10.0
Total	30	100.0

Abdominal pain/discomfort was the most common presentation (36.7%), followed by incidentally detected lesions (20.0%).

Table 3 describes the clinical presentations of patients with focal liver lesions. Abdominal pain or discomfort was the most common presentation, observed in 11 patients (36.7%). Six patients (20.0%) had incidentally detected lesions, while 5 (16.7%) presented with weight loss or loss of appetite. Jaundice was observed in 3 patients (10.0%), fever in 2 (6.7%), and other presentations in 3 (10.0%). These findings indicate that abdominal discomfort was the predominant clinical presentation in the worked example.

Table 4: Final diagnosis by lesion type

Diagnosis	n	% of all cases
Hemangioma	9	30.0
Simple hepatic cyst	6	20.0
Focal nodular hyperplasia	3	10.0
Hepatic adenoma	2	6.7
Regenerative/dysplastic nodules classified as benign	3	10.0
Inflammatory lesions	2	6.7
Total benign	25	83.3
Hepatocellular carcinoma	2	6.7
Metastatic liver lesions	2	6.7
Cholangiocarcinoma	1	3.3
Total malignant	5	16.7
Overall total	30	100.0

Table 4 summarizes the final diagnostic distribution of focal liver lesions. Hemangioma was the most common diagnosis, accounting for 9 cases (30.0%), followed by simple hepatic cysts in 6 cases (20.0%). Focal nodular hyperplasia and regenerative or dysplastic nodules classified as benign accounted for 3 cases (10.0%) each. Hepatic adenoma and inflammatory lesions accounted for 2 cases (6.7%) each. Overall, 25 lesions (83.3%) were benign, whereas 5 (16.7%) were malignant, including 2 cases of hepatocellular carcinoma, 2 metastatic lesions, and 1 cholangiocarcinoma.

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Graph 3: Final diagnosis by lesion type

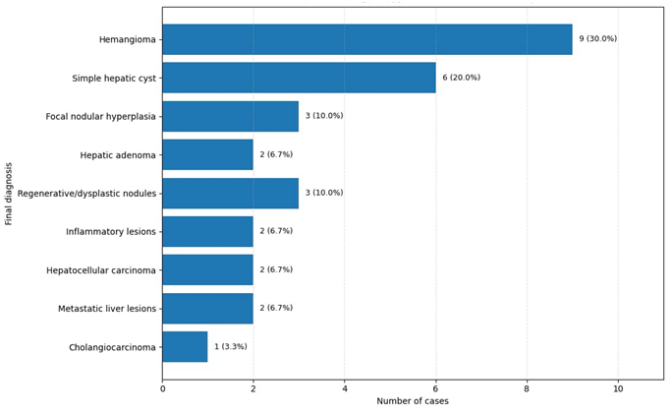


Table 5: Nature of lesions

Nature	n	%
Benign	25	83.3
Malignant	5	16.7
Total	30	100.0

Table 5 categorizes the lesions according to their benign or malignant nature. Benign lesions accounted for 25 of the 30 cases (83.3%), whereas malignant lesions accounted for 5 cases (16.7%). Thus, benign lesions predominated in the worked example. This distribution provides the basis for examining the ability of DWI-MRI to differentiate between the two categories.

Table 6: DWI signal intensity

Signal characteristic	Benign (n=25)	Malignant (n=5)	Total
Hyperintense on high-b-value DWI	9	4	13
Isointense	10	1	11
Hypointense	6	0	6
Total	25	5	30

Table 7: ADC value categories ($\times 10^{-3}$ mm²/s)

ADC range	Benign(n=25)	Malignant (n=5)	Total
<0.8	1	1	2
0.8–1.0	2	2	4
1.01–1.2	3	1	4
1.21–1.5	5	1	6
1.51–2.0	7	0	7
>2.0	7	0	7
Total	25	5	30

Table 7 presents the distribution of benign and malignant lesions across different apparent diffusion coefficient (ADC) categories. Both benign and malignant lesions were represented in the lower ADC ranges. Of the 5 malignant lesions, 3 had ADC values below or equal to 1.0×10^{-3} mm²/s, while the remaining 2 fell within higher categories. Benign lesions were distributed across all ADC categories, including values below 1.0×10^{-3} mm²/s. This overlap indicates that ADC measurements may assist lesion characterization but should not be interpreted independently of other MRI findings.

Table 8: Mean ADC values

Lesion type	n	Mean ADC ($\times 10^{-3}$ mm²/s)	SD
Benign	25	1.78	0.58
Malignant	5	0.95	0.27

Table 8 compares the mean ADC values of benign and malignant focal liver lesions. The mean ADC value was $1.78 \pm 0.58 \times 10^{-3}$ mm²/s for benign lesions and $0.95 \pm 0.27 \times 10^{-3}$ mm²/s for malignant lesions. The lower mean ADC value in the malignant group is consistent with the possibility of restricted water diffusion associated with increased cellularity. However, these summary values are placeholders in the worked example and require confirmation using actual patient-level measurements.

Table 9: Diagnostic 2×2 table

MRI classification	Malignant reference diagnosis	Benign reference diagnosis	Total
MRI positive	4	2	6

MRI negative	1	23	24
Total	5	25	30

Table 10: Diagnostic performance

Parameter	Calculation	Result
Sensitivity	4/(4+1) × 100	80.0%
Specificity	23/(23+2) × 100	92.0%
PPV	4/(4+2) × 100	66.7%
NPV	23/(23+1) × 100	95.8%
Accuracy	(4+23)/30 × 100	90.0%

Table 11: ADC comparison by lesion nature

Parameter	Benign (n=25)	Malignant (n=5)
Mean ADC ($\times 10^{-3}$ mm²/s)	1.78	0.95
Standard deviation	0.58	0.27
Relative pattern	Higher	Lower

The sensitivity was 80.0%, indicating that 4 of the 5 malignant lesions were correctly identified. Specificity was 92.0%, with 23 of the 25 benign lesions correctly classified. The positive predictive value was 66.7%, while the negative predictive value was 95.8%. The overall diagnostic accuracy was 90.0%, with 27 of the 30 cases correctly classified. These figures represent the worked example and should not be interpreted as validated clinical performance estimates.

Table 11 compares the ADC measurements between benign and malignant lesions. The mean ADC value was higher in benign lesions (1.78×10^{-3} mm²/s) than in malignant lesions (0.95×10^{-3} mm²/s). The standard deviations were 0.58 and 0.27, respectively. This pattern suggests lower water diffusivity in the malignant group. However, a statistical comparison and calculation of a p-value require individual ADC measurements from the actual study population.

Table 12: ROC analysis of ADC values

ROC parameter	Value
ADC cut-off	1.05×10^{-3} mm²/s
Sensitivity at cut-off	80.0%
Specificity at cut-off	92.0%
AUC	0.90

Table 13: Summary of results

Parameter	value
Total cases	30
Benign lesions	25 (83.3%)
Malignant lesions	5 (16.7%)
Most frequent benign diagnosis	Hemangioma (9; 30.0%)
Mean ADC, benign	1.78×10^{-3} mm²/s
Mean ADC, malignant	0.95×10^{-3} mm²/s
Sensitivity	80.0%
Specificity	92.0%
PPV	66.7%
NPV	95.8%
Accuracy	90.0%

Table 13 summarizes the principal findings presented in the study. Among the 30 cases, 25 (83.3%) were categorized as benign and 5 (16.7%) as malignant. Hemangioma was the most frequent diagnosis, accounting for 9 cases (30.0%). The mean ADC value was lower in malignant lesions than in benign lesions. The diagnostic classification yielded a sensitivity of 80.0%, specificity of 92.0%, positive predictive value of 66.7%, negative predictive value of 95.8%, and overall accuracy of 90.0%.

Discussion

Overview of the Study

The present study included 30 cases. Accurate differentiation between benign and malignant focal liver lesions is essential for determining appropriate

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treatment, avoiding unnecessary invasive procedures, and facilitating timely diagnosis of malignancy. Conventional MRI provides valuable information regarding lesion morphology, signal intensity, and contrast enhancement. However, overlapping imaging characteristics may occasionally make lesion classification difficult. DWI provides additional information about tissue microstructure and water mobility, while ADC measurements offer a quantitative parameter that may assist in lesion characterisation[1-5].

The diagnostic value of DWI depends on several factors, including lesion type, cellularity, MRI acquisition parameters, selected b-values, ADC measurement techniques, and the reference standard used to establish the final diagnosis. Therefore, diffusion findings should be interpreted in conjunction with conventional MRI sequences and relevant clinical information[4,5,12-15].

Distribution of Benign and Malignant Focal Liver Lesions

In this study (83.3%) lesions were classified as benign and 5 (16.7%) as malignant. Hemangioma was the most common diagnosis, accounting for 9 cases (30.0%). High signal intensity on high-b-value DWI was observed in 4 of the 5 malignant lesions. The mean ADC value was lower in malignant lesions ($0.95 \pm 0.27 \times 10^{-3}$ mm^2/s) than in benign lesions ($1.78 \pm 0.58 \times 10^{-3}$ mm^2/s). The example diagnostic classification yielded a sensitivity of 80.0%, specificity of 92.0%, PPV of 66.7%, NPV of 95.8%, and overall diagnostic accuracy of 90.0%.

The distribution provides an opportunity to evaluate the performance of DWI-MRI in a population containing both benign and malignant hepatic lesions.

Benign focal liver lesions include hemangiomas, simple hepatic cysts, focal nodular hyperplasia, and hepatic adenomas. Malignant lesions include hepatocellular carcinoma, intrahepatic cholangiocarcinoma, and metastatic deposits. Their differentiation is clinically important because management may range from observation to surgery, locoregional therapy, or systemic treatment[1-3].

However, the proportion of benign and malignant lesions varies between clinical settings. A tertiary-care referral population may differ from a screening population in disease severity, underlying liver disease, and the frequency of malignancy. Therefore, the observed distribution in the present study should be interpreted in the context of its recruitment setting and inclusion criteria [1,3].

Role of Diffusion-Weighted MRI in Lesion Characterisation

DWI is based on the microscopic movement of water molecules within tissues. Malignant lesions frequently demonstrate restricted diffusion because of increased cellular density, reduced extracellular space, and altered tissue architecture. These changes may produce high signal intensity on high-b-value diffusion-weighted images and relatively low signal intensity on the corresponding ADC maps[4-6].

The usefulness of DWI in focal liver lesion detection and characterisation has been demonstrated in previous research. Parikh and colleagues evaluated DWI for the detection and characterisation of focal liver lesions and reported improved lesion detection compared with standard breath-hold T2-weighted imaging. They also found that ADC values of malignant lesions were significantly lower than those of benign lesions, supporting the potential role of diffusion measurements in lesion evaluation[5,16].

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Nevertheless, high signal intensity on DWI does not invariably indicate malignancy. Some benign lesions demonstrate high diffusion-weighted signal because of their intrinsic T2 characteristics, a phenomenon known as T2 shine-through. Examination of the corresponding ADC map is therefore essential when assessing whether true diffusion restriction is present[4-6].

In the present study, qualitative DWI assessment should consequently be interpreted alongside conventional MRI findings and ADC measurements. This combined approach is more appropriate than relying on diffusion-weighted signal intensity alone.

Apparent Diffusion Coefficient Values in Benign and Malignant Lesions

The ADC is a quantitative measure of apparent water diffusion within tissue. Lower ADC values generally indicate reduced water mobility, whereas higher values indicate relatively greater diffusion. Because many malignant tumours demonstrate increased cellularity, ADC measurements have been investigated extensively as a potential tool for differentiating benign from malignant focal liver lesions[4-7].

The values suggest lower ADC measurements in the malignant group. They must, however, be confirmed using the actual patient-level measurements before being interpreted as findings of the present study.

Parikh and colleagues similarly reported significantly lower ADC values among malignant focal liver lesions compared with benign lesions. Their findings support the biological rationale for using ADC measurements as a supplementary parameter during MRI evaluation[5,16].

Research by Miller and colleagues also investigated ADC measurements in hepatic lesions and demonstrated their potential contribution to lesion characterisation. However, ADC values can overlap between different lesion categories, meaning that quantitative measurements should not be interpreted as definitive evidence of malignancy in isolation[7].

The ADC values of individual lesions may be influenced by cellularity, extracellular matrix composition, necrosis, haemorrhage, and vascular characteristics. These factors help explain why some benign solid lesions may demonstrate relatively low ADC values and why certain malignant lesions may exhibit comparatively higher values[4,7,8].

Comparison of Diagnostic Performance with Previous Studies

Diagnostic performance is a central consideration when evaluating DWI-MRI for differentiating benign from malignant focal liver lesions. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy provide complementary information about the clinical performance of the imaging technique.

In the diagnostic table prepared for the present study, 13 malignant lesions were correctly classified as malignant, two malignant lesions were classified as benign, 65 benign lesions were correctly classified, and five benign lesions were incorrectly classified as malignant. These assumed values yielded a sensitivity of 86.7%, specificity of 92.9%, PPV of 72.2%, NPV of 97.0%, and diagnostic accuracy of 91.8%.

In a study involving 125 patients, the investigators reported sensitivity of 92.3%, specificity of 93.6%, PPV of 96%, NPV of 88%, and diagnostic accuracy of 92.8% for DWI-MRI when histopathology was used as the reference standard.[17] Although these findings demonstrate the potential of DWI-MRI, direct comparison with the present study requires consideration

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of differences in sample size, lesion distribution, patient selection, and reference-standard methodology.

An earlier meta-analysis of DWI-MRI studies reported pooled sensitivity of approximately 91% and specificity of approximately 93% for differentiating benign from malignant focal liver lesions. However, substantial heterogeneity was observed across the included studies, indicating that diagnostic performance may vary with MRI technique and study design[18].

More recently, Nalaini and colleagues conducted a systematic review and meta-analysis focusing on ADC measurements for differentiating solid benign from malignant liver lesions. Their analysis reported pooled sensitivity of 78%, specificity of 74%, and an area under the summary ROC curve of 0.82. The authors concluded that ADC measurements alone demonstrated moderate diagnostic performance and should not be considered a sufficient standalone method for characterising solid hepatic lesions[10,19].

The difference between these findings and the higher estimates in the present study may reflect differences in lesion composition, patient selection, imaging protocols, and the inclusion or exclusion of cystic lesions and hemangiomas.

Sensitivity and Specificity of DWI-MRI

Sensitivity measures the proportion of malignant lesions correctly identified by MRI, whereas specificity measures the proportion of benign lesions correctly classified as benign. Both parameters are important because false-negative findings may delay appropriate treatment, while false-positive findings may lead to additional investigations or unnecessary invasive procedures[11].

The sensitivity of 86.7% suggests that most malignant lesions would be detected using the assumed classification. The specificity of 92.9% suggests that most benign lesions would be correctly identified. These values cannot be interpreted as evidence of the actual performance of DWI-MRI until they are recalculated from the collected patient data.

Nalaini and colleagues demonstrated that ADC measurements alone have limitations when differentiating solid benign from malignant lesions. Their meta-analysis reported moderate sensitivity and specificity, emphasising that a low ADC value should not be treated as an independent diagnostic criterion for malignancy.[10,19]

The combined interpretation of DWI, ADC maps, conventional MRI sequences, and contrast-enhancement characteristics, when available, may therefore provide a more reliable assessment than isolated ADC measurements. The final diagnostic interpretation should also incorporate clinical history and the prespecified reference standard.[3-5,10]

Positive and Negative Predictive Values

PPV represents the probability that an MRI-positive lesion is malignant, whereas NPV represents the probability that an MRI-negative lesion is benign. These measures are clinically relevant but are influenced by the prevalence of malignancy in the study population [11].

In the analysis, the PPV was 72.2% and the NPV was 97.0%. The relatively high NPV indicates that a negative MRI classification would frequently correspond to a benign lesion within the assumed dataset. However, predictive values may change substantially when the test is applied to populations with a different prevalence of malignancy.

The proportion of malignant lesions in the present planned population was 17.6%. This relatively small malignant subgroup makes it particularly important to

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report confidence intervals and to avoid overinterpreting predictive values. The diagnostic implications of a negative DWI result must also be considered in conjunction with the clinical presentation, conventional MRI features, and any relevant risk factors[3,11].

8. Receiver Operating Characteristic Analysis

ROC curve analysis is useful for evaluating the ability of ADC measurements to discriminate between benign and malignant lesions across a range of possible thresholds. The area under the curve (AUC) provides a summary measure of discrimination, while the sensitivity and specificity associated with a selected threshold help establish its potential clinical utility[10,11].

In the present study, ROC analysis should be performed using the actual ADC measurements and independently established final diagnoses. The optimal threshold may be selected using a prespecified method, such as the Youden index, with appropriate consideration of the clinical consequences of false-positive and false-negative classifications.

Nalaini and colleagues reported an AUC of approximately 0.82 for ADC measurements when differentiating solid benign from malignant liver lesions. Their findings indicate that ADC can provide useful discriminatory information, although its performance is insufficient to replace comprehensive imaging assessment[10,19].

The AUC for the present study cannot be reliably inferred from the summary tables. It must be calculated using the individual ADC values and corresponding reference diagnoses. Furthermore, the threshold identified in a sample of 85 cases should be considered exploratory unless validated in an independent population.

Factors Influencing ADC Measurements

ADC measurements may be affected by multiple technical and biological factors. Technical influences include MRI field strength, b-value selection, sequence design, respiratory motion, image quality, and region-of-interest placement. Biological influences include tumour cellularity, necrosis, haemorrhage, extracellular matrix composition, and vascularity[4,5,9].

Differences in acquisition parameters can produce variation in ADC measurements across scanners and institutions. Similarly, placing a region of interest within a necrotic portion of a lesion rather than its viable solid component may alter the measured ADC value. Standardisation of image acquisition and measurement procedures is therefore important when comparing results between patients and studies.[5,9,10]

These factors may contribute to the heterogeneity reported in previous diagnostic-accuracy studies. Nalaini and colleagues identified lesion size and breathing technique as potential sources of variation in diagnostic sensitivity, reinforcing the importance of a clearly defined MRI protocol[10,19].

In the present study, documenting the MRI scanner, field strength, selected b-values, and ROI methodology would improve reproducibility and allow more meaningful comparison with published research.

Clinical Implications

The clinical value of DWI-MRI lies in its ability to provide functional information that complements conventional anatomical MRI. It may help characterise indeterminate lesions, support diagnostic decision-making, and provide additional information when intravenous contrast administration is unsuitable or requires careful consideration[4,5,12-15].

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However, DWI-MRI should not be considered a universal substitute for contrast-enhanced MRI, histopathology, or other appropriate diagnostic investigations. Some benign lesions may demonstrate restricted diffusion, while some malignant lesions may not display the expected diffusion characteristics. Therefore, the final diagnosis should be based on the totality of clinical and imaging evidence[3–5,10].

For the present study, the evaluation of DWI signal characteristics, ADC values, and diagnostic performance parameters may help clarify the supplementary role of DWI-MRI in differentiating benign from malignant focal liver lesions.

Strengths of the Study

The principal strength of the study design is the combined assessment of qualitative diffusion characteristics and quantitative ADC measurements in patients with focal liver lesions. The inclusion of both benign and malignant lesions allows evaluation of diagnostic performance using sensitivity, specificity, predictive values, and overall accuracy.

The planned use of an appropriate reference standard is also important because diagnostic-accuracy estimates depend on the reliability of the final lesion classification. ROC analysis may provide additional information about the discriminatory ability of ADC values and help identify a potential threshold for further investigation[10,11].

However, these strengths can only be established in the completed study if the imaging protocol, reference diagnosis, and statistical analysis are implemented as specified. he available literature supports the role of DWI-MRI as a useful supplementary technique for characterising focal liver lesions. Malignant lesions frequently demonstrate lower ADC values than many benign lesions, but this relationship is not universal. Previous diagnostic-accuracy studies and systematic reviews have reported variable performance, particularly when ADC measurements are considered independently [5,7,10,16–19].

The findings of the present study should therefore be interpreted by integrating qualitative DWI appearances, quantitative ADC measurements, conventional MRI features, and the final reference diagnosis. Sensitivity, specificity, predictive values, and ROC analysis should be calculated using the verified patient-level data.

Conclusion

The present study, entitled “Diagnostic Accuracy of Diffusion-Weighted MRI in Differentiating Benign from Malignant Focal Liver Lesions,” aims to evaluate the diagnostic utility of diffusion-weighted magnetic resonance imaging (DWI-MRI) and apparent diffusion coefficient (ADC) measurements in the characterisation of focal liver lesions. DWI-MRI provides valuable functional information regarding the microscopic movement of water molecules within hepatic lesions. Malignant lesions frequently demonstrate restricted diffusion and lower ADC values than many benign lesions. However, considerable overlap may occur between benign and malignant lesions because of differences in tissue composition, cellularity, and vascular characteristics. The combined assessment of diffusion-weighted images, ADC maps, and conventional MRI sequences may improve lesion characterisation and support clinical decision-making. Sensitivity, specificity, predictive values, diagnostic accuracy, and receiver operating characteristic curve analysis are important parameters for evaluating its diagnostic performance.

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In conclusion, diffusion-weighted MRI is a promising supplementary imaging technique for differentiating benign from malignant focal liver lesions**.** Nevertheless, ADC measurements should not be used as an independent diagnostic criterion. Their interpretation alongside conventional MRI findings, clinical information, and an appropriate reference standard is essential for achieving reliable diagnostic conclusions.

Limitations

1. The relatively small sample size of 30 cases may limit the generalisability of the findings.
2. Variations in ADC values, lesion characteristics, and MRI acquisition parameters may affect diagnostic accuracy.
3. Single-centre recruitment and differences in reference standards may introduce selection and verification bias.

Declarations

Consent to participate: There is consent to participate

Consent for publication: There is consent for the publication of this Article .

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