

Diagnostic Efficacy of Diffusion Weighted MRI in Discriminating Between Benign and Malignant Hepatic Focal Lesions: A Comparative Study with Conventional Imaging Modalities

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Abstract

Context: Making informed decisions about treatment and prognosis depends critically on the precise identification and description of hepatic localized lesions. Distinguishing between benign and malignant liver lesions has demonstrated potential with diffusion-weighted magnetic resonance imaging (DW-MRI).

Goal: to evaluate the effectiveness of DW-MRI in comparison to other imaging modalities and to determine its diagnostic accuracy in separating benign from malignant hepatic focal lesions.

Techniques: 150 individuals with hepatic focal lesions who had DW-MRIs between January 2019 and December 2022 were the subjects of a retrospective investigation. The reference standard for evaluating the diagnostic performance of DW-MRI was histological examination. The following metrics were computed: accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Conventional imaging modalities such as computed tomography (CT), conventional magnetic resonance imaging (MRI), and ultrasonography (US) were compared.

Findings: DW-MRI showed 92% sensitivity, 88% specificity, and 92% accuracy in separating benign from malignant liver lesions. 0.94 was the area under the ROC curve (AUC). A comparative study showed that DW-MRI performed better in terms of diagnosis than US, CT, and traditional MRI. For the purpose of distinguishing between benign and malignant lesions, the ideal apparent diffusion coefficient (ADC) cutoff values were $1.2 \times 10^{-3} \text{ mm}^2/\text{s}$ for highest specificity and $1.1 \times 10^{-3} \text{ mm}^2/\text{s}$ for maximum sensitivity.

Conclusion: When it comes to the diagnostic algorithm for hepatic focal lesions, DW-MRI is a useful tool since it performs better than traditional imaging modalities and has great diagnostic accuracy in differentiating between benign and malignant lesions.

Keywords: *Hepatic focal lesions, diffusion weighted MRI, benign lesions, malignant lesions, and diagnostic accuracy*

Introduction

Platelets Due to its intricate architecture, the liver is an essential organ that can develop a range of localized lesions, such as cysts,

inflammatory lesions, and benign and malignant tumors [1]. For proper clinical care, treatment planning, and patient prognosis, it is critical to accurately detect, characterize, and differentiate these hepatic focal lesions [2]. Hepatic lesions are frequently evaluated using conventional imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound (US) [3]. However, because of overlapping imaging features, these modalities are inherently limited in their ability to distinguish between benign and malignant hepatic lesions, especially when the lesions are smaller than 2 cm in diameter [4].

Diffusion Weighted Magnetic Resonance Imaging (DW-MRI), which provides functional information based on the diffusion characteristics of water molecules in tissues, has emerged as a viable imaging modality for the assessment of localized lesions in the liver [5]. The apparent diffusion coefficient (ADC), which is used to quantify the random mobility of water molecules within tissues, is measured using DW-MRI [6]. Because of their higher cellularity and less extracellular space, malignant lesions frequently show restricted diffusion, which lowers their ADC values in comparison to benign lesions [7].

Numerous research works have examined the function of DW-MRI in identifying and characterizing localized lesions in the liver, showing how it can enhance both patient care and diagnostic precision [8–10]. To confirm that DW-MRI is a useful tool for differentiating benign from malignant hepatic lesions and to ascertain its place in the diagnostic algorithm, more study is necessary [11]. The current study intends to compare the diagnostic performance of DW-MRI with traditional imaging modalities, such as US, CT, and conventional MRI, and assess its role in detecting and characterizing hepatic focal lesions, as well as in differentiating between benign and malignant lesions.

Materials and Methods

A retrospective analysis was carried out on 150 individuals who had DW-MRIs between January

2019 and December 2022 and had localized lesions in the liver. Patients who were 18 years of age or older, the existence of hepatic focal lesions verified by histological analysis or imaging follow-up, and the availability of comprehensive clinical and imaging data were the inclusion criteria. Individuals with metallic implants, pacemakers, claustrophobia, or other conditions that preclude MRIs were not allowed to participate in the study.

Imaging Protocol A 1.5-T or 3-T MRI machine equipped with a phased-array body coil was used for each DW-MRI test. The imaging protocol comprised DWI, T2-weighted, and axial T1-weighted sequences. A single-shot echo-planar imaging (EPI) sequence with b-values of 0 and 800 s/mm² was used for DWI. The MRI machine produced the ADC maps automatically.

Image Analysis: The DW-MRI pictures were independently assessed by two seasoned radiologists who were blinded to the clinical and histological results. The lesion size, the signal intensity on T1- and T2-weighted images, and the ADC values were evaluated. Lesion areas of interest (ROIs) were plotted on the ADC maps in order to determine the lesions' mean ADC values. The two radiologists' measured ADC values were averaged to provide the final ADC results.

Histological Examination Biopsy or surgical specimens taken from the hepatic focal lesions were subjected to a histological examination. An skilled pathologist who was blind to the imaging results assessed the specimens. The histological investigation allowed for the classification of the lesions as either benign or malignant.

Statistical Analysis: IBM Corp., Armonk, NY, USA's SPSS version 25.0 was used to conduct the statistical analysis. Using histological examination as the reference standard, the following metrics were calculated: sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV) of DW-MRI in differentiating between benign and

malignant hepatic lesions. ADC cutoff value for benign and malignant hepatic lesions was determined by using a Receiver Operating Characteristic (ROC) curve analysis.

Results

Table 1 displays the study population's demographic characteristics. Patients with benign lesions had an average age of 58.4 ± 9.2 years, while those with malignant lesions had an average age of 61.2 ± 8.7 years. The age difference between the two groups was not statistically significant ($P=0.087$). Between the benign and malignant groups, the distribution of genders was similar ($P=0.642$). With a P-value of less than 0.001, the mean lesion size was, nevertheless, considerably greater in the malignant group (4.5 ± 1.2 cm) than in the benign group (2.1 ± 0.6 cm).

The results of DW-MRI for benign and malignant hepatic lesions are summarized in Table 2. 55 (73.3%) malignant lesions and 60 (80%) benign lesions had hypointensity on the T1-weighted images, respectively ($P<0.001$). Similarly, 65 (86.7%) benign lesions and 50 (66.7%) malignant lesions showed hyperintensity and hypointensity, respectively, on T2-weighted images ($P<0.001$). With a P-value of less than 0.001, the ADC values for benign lesions were considerably greater ($1.5 \pm 0.3 \times 10^{-3} \text{ mm}^2/\text{s}$) than those for malignant lesions ($0.9 \pm 0.2 \times 10^{-3} \text{ mm}^2/\text{s}$).

The diagnostic performance of DW-MRI in differentiating between benign and malignant liver lesions is shown in Table 3. With a positive predictive value (PPV) of 90% and a negative predictive value (NPV) of 91%, the DW-MRI demonstrated 92% sensitivity, 88% specificity, and 92% accuracy. With an area under the ROC curve (AUC) of 0.94, the diagnostic performance was outstanding.

Table 4 presents a comparison between the diagnostic performance of DW-MRI and conventional imaging modalities, such as computed tomography (CT), ultrasonography (US), and conventional MRI. With P-values of

0.012, 0.034, and 0.056, respectively, DW-MRI outperformed US, CT, and conventional MRI in terms of sensitivity, specificity, and accuracy.

The best ADC cutoff values for identifying benign from malignant hepatic lesions are displayed in Table 5. ADC cutoff values of $1.1 \times 10^{-3} \text{ mm}^2/\text{s}$ and $1.2 \times 10^{-3} \text{ mm}^2/\text{s}$ were found to yield the highest sensitivity and specificity, respectively.

A comparison between the results of the DW-MRI and the histological study is shown in Table 6. The results of DW-MRI accurately identified 71 (94.7%) malignant lesions and 68 (90.7%) benign lesions in the histological examination, indicating a high degree of concordance.

Discussion

Because benign and malignant liver lesions have different etiologies and overlap in their imaging characteristics, diagnosing and characterizing hepatic focal lesions remains a diagnostic difficulty. The purpose of this study was to compare the diagnostic performance of diffusion weighted magnetic resonance imaging (DW-MRI) with traditional imaging modalities and assess the utility of DW-MRI in differentiating between benign and malignant liver lesions.

DW-MRI's Diagnostic Accuracy

Based on our investigation, DW-MRI offers a 92% sensitivity, 88% specificity, and 92% overall diagnostic accuracy in differentiating between benign and malignant hepatic lesions. These results are in line with other research that found that DW-MRI had a good diagnosis accuracy when assessing hepatic abnormalities [1,2]. The capacity of DW-MRI to offer functional information based on the diffusion characteristics of water molecules in tissues is responsible for its excellent sensitivity and specificity. Because of their higher cellularity and reduced extracellular space, malignant lesions frequently show restricted diffusion, which lowers their ADC values in comparison to benign lesions [3].

Comparative Analysis of Traditional Imaging Techniques

In our investigation, DW-MRI outperformed traditional imaging modalities like computed tomography (CT), ultrasonography (US), and conventional MRI in terms of diagnostic performance. The greater sensitivity, specificity, and accuracy of DW-MRI in our investigation are in line with earlier research that has demonstrated DW-MRI's superiority over traditional imaging modalities in the assessment of liver lesions [4,5].

Because ultrasonography (US) is widely available and reasonably priced, it is frequently utilized as the first imaging modality for the evaluation of hepatic abnormalities. Nevertheless, US is not always able to distinguish benign from malignant hepatic lesions, especially when the lesions are smaller than 2 cm in diameter [6]. Our research showed that US performed less well as a diagnostic tool than DW-MRI, with a sensitivity of 78% and specificity of 72% in identifying benign from malignant hepatic lesions.

Another frequently utilized imaging modality for the assessment of hepatic abnormalities is computed tomography (CT). When it comes to identifying calcifications and vascular invasion in hepatic diseases, CT offers exceptional spatial resolution [7]. However, because of overlapping imaging features, CT is not always able to distinguish between benign and malignant hepatic tumors [8]. Our research showed that CT performed less well as a diagnostic tool than DW-MRI, with a sensitivity of 85% and specificity of 80% in identifying benign from malignant hepatic lesions.

T1- and T2-weighted signal intensities can be used to characterize hepatic lesions with conventional MRI, which offers good soft tissue contrast [9]. However, because of overlapping imaging features, particularly in tumors with unusual imaging findings, conventional MRI is limited in its ability to distinguish between benign and malignant hepatic lesions [10]. Our research showed that DW-MRI outperformed

conventional MRI in terms of diagnostic performance, with a sensitivity of 89% and specificity of 84% in identifying benign from malignant hepatic lesions.

Ideal ADC Cutoff Points

The best ADC cutoff values for separating benign from malignant hepatic lesions were found by our research. ADC cutoff values of $1.1 \times 10^{-3} \text{ mm}^2/\text{s}$ and $1.2 \times 10^{-3} \text{ mm}^2/\text{s}$ were found to yield the highest sensitivity and specificity, respectively. These results are in line with other research that found the best ADC cutoff values for identifying benign from malignant hepatic lesions [11,12]. Determining the ideal ADC cutoff values might be helpful in correctly diagnosing and treating localized liver lesions, especially when the lesions present with unusual imaging features.

Comparing the Results of DW-MRI with Histopathological Analysis

With 68 (90.7%) benign lesions and 71 (94.7%) malignant lesions accurately detected by DW-MRI, our study showed a high degree of agreement between DW-MRI findings and histological testing. These results are in line with other research that found a strong correlation between the evaluation of hepatic lesions by DW-MRI and histological inspection [13, 14]. The diagnostic accuracy of DW-MRI in differentiating between benign and malignant liver lesions is further validated by the remarkable concordance between the findings and the histological testing.

Clinical Consequences

Our study's excellent DW-MRI diagnosis accuracy has significant practical ramifications for the treatment of individuals with hepatic focal lesions. For proper clinical care, treatment planning, and patient prognosis, it is essential to accurately distinguish between benign and malignant hepatic lesions [15]. Hepatic focal lesions can be accurately and quickly diagnosed with the use of DW-MRI, which can lead to better patient outcomes and proper therapeutic care.

Limitations

It is important to take into account the many limitations of our study when evaluating the findings. First off, the results may not be as broadly applicable as they may be because this was a retrospective study with a limited sample size. Larger sample sizes and further prospective studies are required to confirm that DW-MRI is a reliable diagnostic tool for differentiating between benign and malignant liver lesions. Furthermore, future research should assess the diagnostic accuracy of DW-MRI in particular types of hepatic lesions, such as cholangiocarcinoma, hepatocellular carcinoma, and hepatic metastases, as the study encompassed a heterogeneous collection of hepatic lesions. Third, future research should assess the cost-effectiveness of DW-MRI in the assessment of hepatic lesions, as this study did not compare it to other conventional imaging modalities.

Conclusion

To sum up, our research indicates that DW-MRI outperforms traditional imaging modalities in terms of diagnostic performance and has good diagnostic accuracy in differentiating between benign and malignant hepatic lesions. Finding the best ADC cutoff values can help ensure that hepatic focal lesions are diagnosed and treated correctly. In the diagnostic strategy for hepatic focal lesions, DW-MRI is a useful tool that promotes fast and accurate diagnosis as well as better patient outcomes.

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Tables

Table 1: Demographic Characteristics of the Study Population

Characteristics	Benign Lesions (n=75)	Malignant Lesions (n=75)	P-value
Age (years)	58.4 ± 9.2	61.2 ± 8.7	0.087
Gender (M/F)	40/35	42/33	0.642
Lesion Size (cm)	2.1 ± 0.6	4.5 ± 1.2	<0.001

Table 2: DW-MRI Findings in Benign and Malignant Hepatic Lesions

Parameters	Benign Lesions	Malignant Lesions	P-value
T1-weighted (Hyperintense/Hypointense)	60/15	20/55	<0.001
T2-weighted (Hyperintense/Hypointense)	65/10	25/50	<0.001
ADC values ($\times 10^{-3} \text{ mm}^2/\text{s}$)	1.5 ± 0.3	0.9 ± 0.2	<0.001

Table 3: Diagnostic Performance of DW-MRI in Discriminating Benign and Malignant Lesions

Parameters	DW-MRI
Sensitivity	92%
Specificity	88%
Accuracy	92%
PPV	90%
NPV	91%
ROC AUC	0.94

Table 4: Comparison of DW-MRI with Conventional Imaging Modalities

Imaging Modalities	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-value
US	78	72	75	0.012
CT	85	80	82	0.034
Conventional MRI	89	84	87	0.056

Table 5: Optimal ADC Cutoff Values for Differentiating Benign and Malignant Lesions

Parameters	ADC Cutoff Value ($\times 10^{-3} \text{ mm}^2/\text{s}$)
Maximum Sensitivity	1.1
Maximum Specificity	1.2

Table 6: Comparative Analysis of DW-MRI and Histopathological Examination

Parameters	DW-MRI Findings	Histopathological Findings
Benign Lesions	68	67
Malignant Lesions	71	72

Note: P-values less than 0.05 were considered statistically significant.