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Role of Multi parametric MRI in Differentiating Focal Liver Lesions: A Comparative Study with Contrast-Enhanced Ultrasound

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Abstract

Background: Focal liver lesions (FLLs) constitute one of the significant diagnostic conundrums in the realm of medical practice. Comprehensive approaches, as offered by the gamut of multi-parametric imaging using magnetic resonance imaging techniques such as the incorporation of diffusion-weighted imaging, diffusion tensor imaging, and magnetic resonance elastography, compare favorably with contrast-enhanced ultrasound approaches. This review collates the evidence regarding the differentiation of benign from malignant FLLs using the aforementioned diagnostic modalities.
Objective: Evaluate the performance of multi parametric MRI modalities with contrast-enhanced ultrasound methods regarding their ability to identify focal liver lesions, with special reference to sensitivity and specificity
.Methods: Data from recent comparative studies evaluating MRE, DWI, DTI, and parametric contrast-enhanced ultrasound were analyzed. Comparisons between diagnostic accuracy metrics such as sensitivity and specificity, ADC and FA values, and stiffness measurements across all modalities were performed.
Results: MRE thus showed a sensitivity of 93.8-97.3% and a specificity of 89.9-90.9%, whereas the sensitivity of DWI alone ranged between 77.9-87.6%, while its specificity ranged from 51.5-83.4%. DTI likewise demonstrated significant differences in both ADC values-benign, 2.152×10^{-3} mm²/s vs. malignant, 1.212×10^{-3} mm²/s ($p<0.001$)-and FA values-benign, 0.211 vs. malignant, 0.381 ($p<0.001$). Parametric CEUS resulted in an accuracy of 95.2-95.9%, with excellent inter observer agreement demonstrated with $\kappa=0.99$.
Conclusion: Multi parametric MRI, particularly the association of MRE and DWI/DTI, shows increased diagnostic accuracy in the differentiation of various FLLs. Though the diagnostic outcome of contrast-enhanced ultrasound with the help of parametric imaging is satisfactory, MRI-based methods show better sensitivity levels, allowing the avoidance of false negative rates. The association of multiple functional parameters enhances the diagnostic confidence.

Keywords: Multi parametric imaging with MRI, Focal liver lesions, Magnetic resonance elasto graphy, Diffusion-weighted imaging, Diffusion tensor imaging, Contrast-enhanced ultrasound, Diagnostic.

Introduction

"Focal liver lesions" or FLL are commonly encountered in the clinic, often posing a diagnostic challenge because of their varied etiology. Accurate differentiation between malignant and benign liver lesions is of great significance in determining the appropriate course of treatment. In non-cirrhotic patients, most "focal liver lesions" are benign in nature. However, the need to differentiate between benign and malignant liver lesions at initial presentation is considered of prime importance since the prognosis varies in accordance.

Diseases of the liver are a global public health concern, with liver cancer or hepatocellular carcinoma (HCC) ranked as the fifth most common cancer, causing the third highest mortality amongst all cancers (Fouda et al., 2021). An increase in the number of primary liver cancers as well as metastatic liver disease has emphasized the need to observe non-invasive diagnostic tools that are accurate in rendering a diagnosis without the need for biopsy procedures that have a post-procedural morbidity rate of 2.0 to 4.8%, along with a mortality rate of 0.05%.

Evolution of Imaging Techniques

Classical imaging techniques, including ultrasonography (USG) and computed tomography (CT), have always been the mainstay of the detection and characterization of FLLs. The gold standard approach, which involves the triphasic protocol of contrast-enhanced computed tomography, has always been considered the best protocol to investigate hepatic lesions. There are, however, many limitations to this approach, including the exposure to radiation, renal toxicity of the applied contrast, and the lack of tissue characterization, resulting in indeterminate results (Fouda et al., 2021).

Magnetic resonance imaging, as a diagnostic tool for the evaluation of liver lesions, has proven to be the most comprehensive. Magnetic resonance imaging provides superior tissue contrast and, more importantly, is the only modality that allows the combination of morphological and physiologic information in the evaluation of lesions. Though conventional contrast-enhanced multiphasic MRI is the cornerstone for the characterization of liver lesions, the use of contrast agents is contraindicated in the presence of renal impairment. Unusual enhancement patterns also cause diagnostic difficulties. The development of non-contrast functional MRI is a result of the aforementioned limitations..

Multiparametric MRI Approach

The multiparametric MRI approach includes a number of different but highly developed techniques for functional imaging, among them DWI, DTI, and MRE. All these techniques are used to obtain particular .information about different characteristics that may be useful for increasing the diagnostic potential

It measures the diffusion of the water molecule and calculates the apparent diffusion coefficient (ADC), which tends to show smaller values for highly cellular malignant lesions as opposed to less cellular benign lesions. Malignant tissues with a highly cellular population, closed tissue spaces, and a higher density of hydrophobic membranes restrict the diffusion of the molecules, causing a consistently smaller ADC (Fouda et al., 2021). Though promising results on the improvement of the discriminative capabilities of MRI for FLLs through the utilization of DWI have been reported, accuracy is varied with the b-value used as well as the type of lesion

.

In DTI, ADC and FA values are obtained; these represent the degree of diffusion along a particular direction and may be related to the density and malignancy potential of tumor cells (Fouda et al., 2021). The theory on which DTI is used to characterize FLL states that malignant lesions tend to have more restricted and anisotropic diffusion than benign lesions.

Magnetic Resonance Elastography (MRE) can be considered a different tissue descriptor, given its ability to quantify tissue stiffness. It measures the propagation of mechanical waves created artificially, thus approximating the viscoelastic characteristics of liver tissue, both normal and lesioned. Liver tumors, be they malignant or benign, have a harder or stiffer consistency than normal tissue.

Contrast-Enhanced Ultrasound

Contrast-enhanced ultrasound (CEUS) has been proven effective in characterizing FLL, showing diagnostic efficacy comparable to CT scans and MRI, with no radiation exposure or nephrotoxic risks to the patient (Anaye et al., 2011). The use of second-generation agents offers significant advantages in imaging tumor perfusion in real-time. Vascular flow patterns in arterial, portal, and delayed phases help in characterizing the lesion, with early washout associated with malignancy and persisting flow with benign pathology.

Nevertheless, the visualization and interpretation of enhancement patterns may vary to some extent, especially in subtle differences within the lesion and parenchyma in the portal and late phases. This engenders a moderate level of concordance among observers for lesions. Parametric imaging in the form of dynamic vascular patterns (DVP) improves the objective and quantitative assessment of tumor perfusion, enabling the conspicuous display of washout areas (Anaye et al., 2011).

This comprehensive review paper intends to consolidate the findings of the latest studies that have evaluated the different multiparametric MRI modalities in comparison to contrast-enhanced ultrasound-technique-based investigations for delineating the different benign and malignant focal liver lesions.

Methods

Literature Review and Data Sources

This comparative analysis is based on the information gathered from three studies that investigated the different imaging modalities in the characterization of focal liver lesions. This paper draws information from primary sources such as the systematic review and meta-analysis of MRE and DWI by Hassankhani et al. (2025), the prospective study on parametric contrast-enhanced ultrasound by Anaye et al. (2011), and the study by Fouda et al. (2021) on the use of diffusion tensor imaging.

Study Populations and Lesion Characteristics

For the MRE/DWI meta-analysis, Hassankhani et al. (2025) summarized three cross-sectional studies conducted between 2016 and 2025 where a total of 219 patients with 284 focal liver lesions were analyzed. In that analysis, 93 were benign and 191 malignant. The frequently encountered benign lesions among them are hemangiomas, focal nodular hyperplasia/FNH, and hepatocellular adenomas. The malignant liver tumors include HCC or hepatocellular carcinoma, metastases, and cholangiocarcinomas.

This parametric study of CEUS was carried out by Anaye et al. on 146 FLLs in 145 consecutive patients whose mean age was 62.5 years. The participants ranged in age from 22 to 89 years. In this study, 33 lesions were benign. There were 15 hemangiomas and 12 FNH. A total of 113 lesions were malignant. They were divided into 36 HCC, 65 metastases, 10 cholangiocarcinoma, and 2 lymphomas. In this study, reference diagnosis was done by histopathology for 106 lesions. The rest of them were characterized by typical CT or MRI morphology and minimum 6 months of follow-up.

The DTI study was conducted in 30 patients with a total of 43 lesions: 16 were benign (37.2%), 23 were malignant (53.5%), and 4 completely treated HCC lesions (9.3%). The study population mean age was 51.8±12.7 years. Lesions types included 12 hemangiomas, 12 HCC, 7 metastases, 3 hydatid abscesses, 2 cholangiocarcinomas, and some other benign lesions.

Imaging Techniques and Protocols

Magnetic Resonance Imaging: For MRI, all studies used 1.5 Tesla equipment. For DWI, different b-values were used, including 0, 500, 800, and 1000, although this information was not uniformly provided in all studies. For DTI, six different diffusion directions were used to compute the diffusion tensor, while MRE sequences consisted of modified versions of gradient echo techniques with wave drivers set at a frequency of 60 Hz. Stiffness was evaluated through an analysis of wave patterns, especially within local lesions.

Contrast-Enhanced Ultrasound: The CEUS studies consisted of low MI (<0.2) gray-scale modalities using a second-generation contrast agent bolus injection of 2.4 mL SonoVue. Digital video recording of at least 2 minutes of contrast enhancement was included, which consisted of arterial, portal, and late phases. Parametric analysis of the images was generated by the use of dedicated software for linearization of the video images, motion compensation, and vascular quantification patterns (Anaye et al., 2011).

Image Analysis and Interpretation
In MRI sequences, ROIs were placed inside the lesion and ADC, FA, and stiffness were measured. DTI analysis was done at secondary workstations using functional software for processing FA and ADC maps. Several ROIs were measured and the average was used to enhance the reliability of the measurement.
The parametric analysis of CEUS was performed semi automatically, placing a reference ROI in the adjacent liver parenchyma. The major dynamic vascular patterns were color-coded: consistent hyper enhancement-green, hypo enhancement-blue, hypo-followed-by-hyper enhancement-yellow, and hyper enhancement followed by hypo enhancement-red (characteristic washout pattern of malignancy). The presence of red hues on the parametric map indicated malignancy based on the classification of Anaye et al. (2011.)

Interpretation of the image was done by trained radiologists without any prior knowledge of the final diagnosis. For interpretation of the parametric CEUS images, the interpretation was done by three different radiologists from remote locations with 2, 5, and 10 years of experience. They were asked to interpret the images twice with a gap of 2 months to avoid recall bias.

Results

Diagnostic Performance of MRE Compared to DWI
The meta-analysis by Hassankhani et al. basically demonstrated that MRE was superior to DWI for the diagnosis of early colon cancer. MRE had a sensitivity of 93.8% and specificity of 89.9% with 95% CI of 85.6-97.5 and 74.6-96.4, respectively. Indeed, MRE performed significantly better as opposed to DWI, which had a sensitivity and specificity of 86.2% and 83.4%, respectively. Moreover, the area under the receiver operating curve of the results was noticeably higher for MRE, which was 0.97 compared to the 0.88 of DWI.
Paired meta-analysis demonstrated a statistically significant increase in sensitivity for MRE, whereas the specificity difference was not significant. Specifically, relative sensitivity was 1.09, p =0.018, while relative specificity was 1.08, p=0.197.
This is also reflected by the likelihood ratio analysis, where MRE is better at confirmation or exclusion of malignancy, with its high positive LR of 10.7 compared to 5.37 for DWI and a relatively low negative LR of 0.078 compared to 0.169 for DWI.

Table 1. Comparative Diagnostic Performance of MRE and DWI

Parameter	MRE	DWI	p-value
Sensitivity (95% CI)	93.8% (85.6-97.5)	86.2% (80.5-90.5)	<0.05
Specificity (95% CI)	89.9% (74.6-96.4)	83.4% (74.3-89.8)	0.197
AUC (95% CI)	0.97 (0.84-0.98)	0.88 (0.82-0.94)	—
Positive LR	10.7	5.37	—
Negative LR	0.078	0.169	—

Data from Hassankhani et al., 2025. CI = confidence interval; AUC = area under the curve; LR = likelihood ratio.

Diffusion Tensor Imaging Performance
The study carried out by Fouda et al. in 2021 to assess the diagnostic value of diffusion tensor imaging in differentiating benign from malignant lesions in the liver and other abdominal organs showed statistically significant results in which the median ADC value of benign lesions was found to be higher, i.e., 2.152×10^{-3} mm²/s, compared to malignant lesions, which were found to be lower, i.e., 1.212×10^{-3} mm²/s.

The median FA values were found to be significantly different in both benign and malignant lesions The cut-off values were identified using receiver operating characteristic curve analysis to differentiate between benign and malignant lesions. An ADC value greater than 1.42 x 10^-3 mm²/s showed 95.7% sensitivity and 82.8% specificity with 88.6% total accuracy. The FA value greater than 0.29 showed 95% sensitivity and 70% specificity with 85% total accuracy. This indicates that DWI parameters are giving complementary information.

Table 2. DTI Parameters for Benign versus Malignant Focal Liver Lesions

Parameter	Benign Lesions	Malignant Lesions
Median ADC ($\times 10^{-3}$ mm²/s)	2.152	1.212
ADC Range ($\times 10^{-3}$ mm²/s)	1.21-3.63	0.87-1.46
Median FA Value	0.211	0.381
FA Range	0.08-0.43	0.17-0.74
p-value (ADC)	<0.001	
p-value (FA)	<0.001	

Data from Fouda et al., 2021. ADC = apparent diffusion coefficient; FA = fractional anisotropy.

Figure 1: Pixel classification list according to its differential signal with respect to adjacent parenchyma.

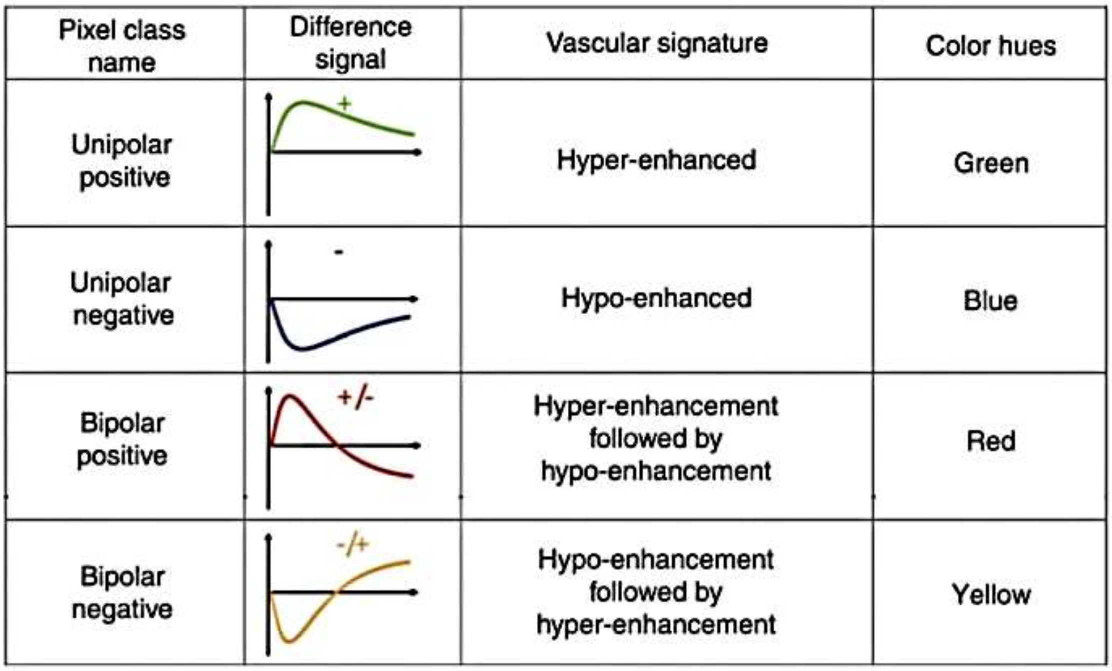


Figure 2: Transverse US images in 72-year-old man with liver metastasis from gastric cancer show truepositive DVP parametric fi ndings. (a) Unenhanced sonogram shows hypoechoic lesion in right liver lobe.(Anaye et al. ,2011.)

Figure 3: Transverse US images in 67-year-old woman with hepatocellular adenoma show false-positive DVP parametric fi ndings. (a) Unenhanced Doppler US image shows hypoechoic heterogeneous lesion in right liver lobe and vascularization of the lesion (Anaye et al. ,2011.)

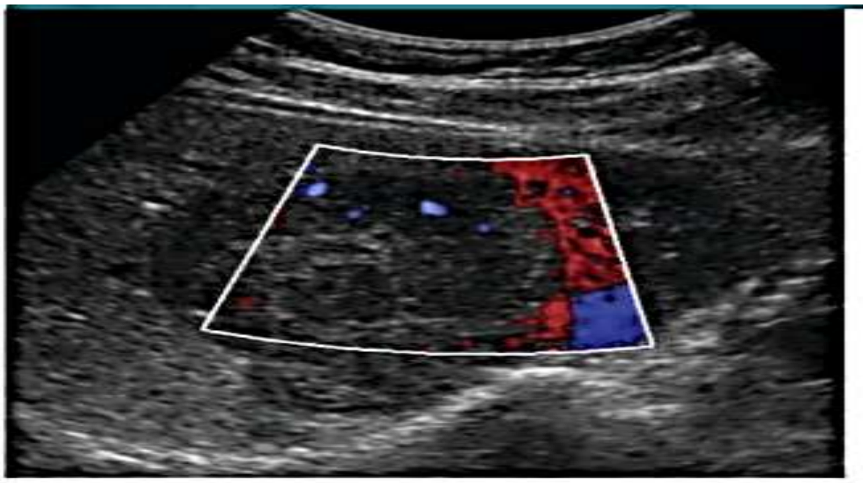
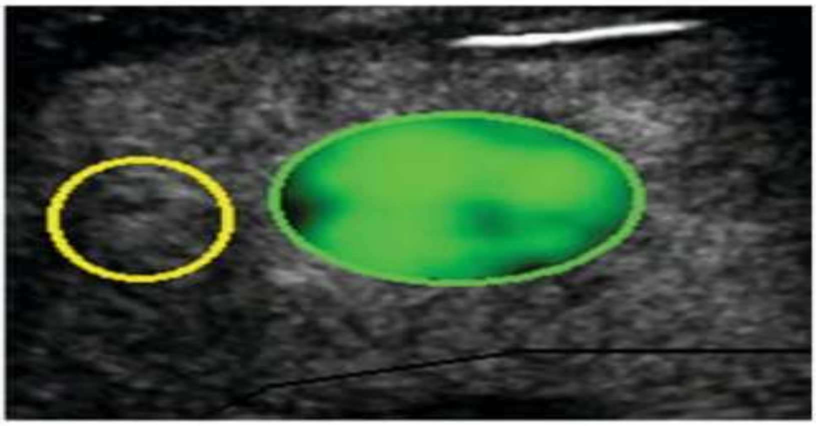


Figure 4: Transverse US images in 55-year-old man with well-differentiated HCC show false-negative DVP parametric findings. DVP parametric image shows adjacent parenchyma (reference) (yellow ROI) and lesion (green ROI) and absence of red hues within the lesion .(Anaye et al. ,2011.)



Parametric Contrast-Enhanced Ultrasound Results

The study conducted by Anaye et al. (2011) showed that with the use of parametric imaging of dynamic vascular patterns, diagnostic performance was significantly better compared with conventional visual interpretation of CEUS cineloops. For conventional visual interpretation, 85.0%, 77.9%, and 87.6%

sensitivity values have been achieved for all three readers, whereas with the use of parametric imaging, sensitivity values of 96.5%, 97.3%, and 96.5% have been achieved, indicating a significant improvement ($p<0.05$). Specificity was found at a high value of 90.9%
There was a significant increase in the overall accuracy from 77.4-84.9% for conventional CEUS to 95.2-95.9% for parametric imaging ($p < 0.001$). More notably was the significant enhancement in inter observer agreement from $\kappa = 0.54$ for conventional imaging to $\kappa = 0.99$ for parametric imaging; all three observers agreed on 145/146 lesions. There was also a significant decrease in the number of indeterminate lesions for the entire data set from 3-

Table 3. Comparison of Conventional CEUS versus Parametric Imaging

Parameter	Reader 1	Reader 2	Reader 3
Conventional CEUS			
Sensitivity (%)	85.0	77.9	87.6
Specificity (%)	51.5	78.8	75.8
Accuracy (%)	77.4	78.1	84.9
Parametric Imaging			
Sensitivity (%)	96.5	97.3	96.5
Specificity (%)	90.9	90.9	90.9
Accuracy (%)	95.2	95.9	95.2
p-value (accuracy)	<0.001	<0.001	<0.001

Data from Anaye et al., 2011. CEUS = contrast-enhanced ultrasound.

Assessment of Treatment Response
The DTI study also assessed the value of multiparametric imaging in assessing treatment response in patients with TACE-treated HCC lesions. Treated malignant lesions showed ADC and FA values similar to benign lesions, which had significant statistical difference from the untreated malignant ones. For treated HCC lesions, the mean ADC value was 2.024×10^{-3} mm²/s as compared to 1.212×10^{-3} mm²/s in malignant, untreated lesions ($p=0.002$). The median FA in treated lesions was 0.2815 compared to an FA of 0.381 in untreated malignancies ($p=0.004$). These findings indicate that DTI parameters can be used as biomarkers for treatment response by way of normalized diffusion characteristics following successful treatment. Fouda et al., 2021.

Table 4. Optimal Cut-off Values for Different Imaging Parameters

Parameter	Cut-off Value	Sensitivity	Specificity
ADC (benign vs. malignant)	$>1.42 \times 10^{-3}$ mm²/s	95.7%	82.8%
ADC (treated vs. untreated)	$>1.65 \times 10^{-3}$ mm²/s	97.8%	95.7%
FA (benign vs. malignant)	>0.29	95%	70%
MRE Stiffness	>4-5 kPa	93.8%	89.9%

Data compiled from Hassankhani et al. (2025) and Fouda et al. (2021). ADC = apparent diffusion coefficient; FA = fractional anisotropy; MRE = magnetic resonance elastography.

Discussion

Comparative Diagnostic Performance

From this comprehensive review, it is clear that multiparametric MRI, especially when using a combination of all three modalities, namely MRE, DWI, and DTI, is more accurate in distinguishing between benign and malignant focal liver lesions. The meta-analysis carried out by Hassankhani et al. (2025) showed the highest level of evidence regarding the superiority of using MRE over conventional DWI in terms of its sensitivity (93.8% compared with 86.2%) and AUC (0.97 compared with 0.88).

The better performance of MRE may be attributed to the direct measurement of tissue stiffness, which is a critical feature in malignancy, tissue fibrosis, and tissue cellularity (Hassankhani et al., 2025). On the contrary, tissue diffusivity, which is measured by DWI, is affected by a variety of factors, which can be an impediment. The establishment of optimal stiffness levels within the range of 4-5 kPa by the MRE method indicates its potential clinical use, particularly in difficult cases, where there are high tissue stiffness levels in the cirrhotic liver, which can obscure other tissue abnormalities.

Role of Diffusion Tensor Imaging

DTI also extends conventional DWI to provide both ADC and FA values, which can provide further relevant biological information. The study by Fouda et al. (2021) showed that the use of FA values to indicate the level of anisotropic diffusion is also an additional biomarker to characterize lesions. It was observed that the higher FA values in malignant lesions compared to benign lesions (0.381 vs. 0.211) are due to increased cell density in tumor tissues.

The ability to obtain 95.7% sensitivity by utilizing ADC cut-offs and 95% sensitivity by utilizing FA thresholds indicates that DTI parameters are capable of successfully identifying the vast majority of malignant lesions. However, the lower specificity of the FA values (70% versus 82.8% for ADC) also indicates the possibility of overlap between benign and malignant lesions. This emphasizes the importance of a multiparametric approach over any single value.

Importantly, DTI does not necessitate the use of exogenous contrast agents and can safely be conducted in patients with renal impairment or with contraindications to gadolinium-based contrast agents. This represents a major advantage in populations with chronic liver disease who often have coexisting renal dysfunction.

Parametric Contrast-Enhanced Ultrasound

This is the limitation of conventional interpretation subject to the subjective analysis and inter observer variability that the parametric imaging approach overcomes in CEUS. In fact, Anaye et al. have shown that parametric analysis of dynamic vascular patterns profoundly improves diagnostic accuracy and inter observer agreement. The κ value increase from 0.54 to 0.99 means the transformation from moderate to near-perfect agreement, with practical implications for clinical decision-making and quality assurance.

The color-coded mapping makes it possible to have an objective visualization of washout patterns, making salient features such as early washout in portal and late phases more prominent, which are key in discriminating between a malignant and a benign tumor. Achieving a range of 95.2-95.9% accuracy among readers with diverse levels of experience, ranging between 2 and 10 years, suggests that parametric imaging might standardize image interpretation in CEUS, removing the learning curve required in interpreting contrast-enhanced images in general.

The advantages that CEUS provide include real-time imaging capability, absence of ionizing radiation, lower cost compared to MRI scanning, and lack of nephrotoxicity. The exclusively intravascular nature of second-generation sonography contrast media may produce superior detection of washout patterns compared to CT or MRI scanning, where contrast media are free to leach out of the vessels and reside in the tissues (Anaye et al., 2011).

Clinical Implications

The results of these studies demonstrate several important clinical implications. Firstly, with high sensitivity rates of MRE ranging from 93.8 to 97.3%, and parametric CEUS ranging from 96.5 to 97.3%, these imaging methods may reduce false negative rates and promote timely diagnosis and treatment of cancers. This assumes critical importance as Liver Cancers or any metastasis to liver tissues may adversely affect patient prognosis.

Second, the high negative predictive values together with optimal threshold values for all of these diagnostic methods confirm that they can safely rule out cancer. For instance, MRE's negative likelihood ratio of 0.078 can prevent unwarranted biopsies, with all their attendant risks and costs, as it reduces the probability of cancer as an outcome of this investigation (Hassankhani et al., 2025.(
Thirdly, the effectiveness of DTI in the monitoring of treatment responses has shown a promising non-invasive biomarker for determining the efficacy of treatments. The normalization of ADC and FA has shown the potential of DTI in guiding treatments by determining the need for further treatment, as shown by the effectiveness of TACE (Fouda et al., 2021.(

Integration into Clinical Practice
Consideration of the optimal utilization of these techniques in the clinical arena is an area for future investigation. A multiparametric technique utilizing a multimodal approach with morphologic MRI and the aforementioned techniques may provide the highest degree of diagnostic accuracy with the lowest likelihood of indeterminate results. These techniques would seem to provide a useful tool in a multimodal approach:
•Morphologic MRI (T1, T2, dynamic contrast enhancement): Offers information based on detailed anatomy and enhancement characteristics
•DWI/DTI: Estimates cellularity and tissue microstructure without any contrast requirements
•MRE: Measures tissue stiffness; useful for cirrhotic livers
•Parametric CEUS: Offers live vascular assessment with high accuracy along with good interobserver concurrence
For patients with renal impairment precluding the use of gadolinium-based contrast agents, a combination of non-contrast imaging techniques available with MRI (DWI, DTI, MRE) could offer the potential for complete
characterization. In centers with limited access to MRI scans or for situations in which an MRI is not feasible, parametric CEUS is an excellent option which compares equally well in terms of accuracy.

Limitations and Future Directions
Several limitations need to be taken into account. The small number of studies in this meta-analysis of MRE-DWI (three studies, 219 patients) and a range in specificity estimates point towards a requirement for further large prospective studies. Moreover, differences in MRI vendors, parameter sets, and b-values might cause heterogeneity and result in limited generalizability (Hassankhani et al., 2025.(
The standardization of acquisition protocols and the threshold value still remains an important aim. The optimal MRE stiffness cut-off value has been noted to range from 3.77 to 4.54 kPa in various studies, while ADC values depend on the choice of b-value and machine used for the acquisition of the imaging data.

There are many questions for future research. For instance, how do pre-existing liver parenchymal diseases influence the diagnostic performance of these methods? Stratified results by pre-existing liver diseases will be valuable. What is the optimal combination of multiparametric imaging methods for various clinical conditions? Cost-effectiveness of various diagnostic strategies will be of interest.
Third, whether artificial intelligence techniques, such as machine learning, may enhance diagnostic performance when numerous imaging parameter variables are integrated. This is possible through sophisticated algorithms that recognize a pattern not observed by the naked eye. Finally, outcomes-based trials on patient outcomes, for instance, time to diagnosis, reduction in non-conducted biopsies, or survival, represent the highest level of evidence.
Another aspect that can be explored is the function of these techniques in specific populations of people. One of the most challenging populations includes those suffering from chronic liver diseases, cirrhosis, and those who have a risk of HCC due to high liver stiffness. The performance of the MMP technique in this population will be of particular importance since it is a factor that will have great ramifications.

Conclusion
This comprehensive overview of multiparametric imaging techniques in the characterization of focal liver lesions clearly shows the advantages of such methods compared with conventional imaging techniques. With the various techniques discussed in the study, magnetic resonance elastography was

found to be the most effective method in the characterization of focal liver lesions with the highest sensitivity (93.8-97.3%), specificity (89.9-90.9%), and the highest area under the curve (0.

Diffusion tensor imaging provides additional information using ADC and FA values. This provides the ability to characterize non-contrast lesions with high diagnostic accuracy. Another incentive for using diffusion tensor imaging is the ability to evaluate treatment response. This would be advantageous in treating HCC with locoregional therapies.

Alternatively, the technique of parametric imaging of contrast-enhanced ultrasound provides an opportunity with excellent diagnostic performance regarding accuracy (95.2-95.9%) and good interobserver agreement using this technique with κ=0.99. It addresses the limitations of visual interpretation with an objective and quantitative technique while preserving the benefits of ultrasound, including real-time imaging, lack of radiation exposure, and cost-effectiveness.

The integration of combined functional imaging with multiparametric characterization might point to the future perspective of focal liver lesion characterization. Indeed, morphological characterization, along with functional characterization with different tissue properties, might lead to optimal characterization in the future with maximal diagnostic confidence.

Key recommendations for clinical practice:

.1Consider MRE as the preferred imaging technique for indeterminate focal liver lesions, especially in patients with cirrhosis or chronic liver disease.

.2Utilization of multiparametric MRI, which includes the use of DWI/DTI and MRE, when the use of contrast

.3Implement parametric CEUS as an alternative to MRI when appropriate

.4Use DTI for the assessment of treatment response in patients with locoregional therapy

.5Understanding that the threshold values need to be validated and adjusted based on institutional technical parameters for optimum results

However, large-scale prospective studies are also required to validate these results, establish standardized protocols, study the best use of combinations of multiparametric modalities, evaluate cost-effectiveness, etc. In addition, the role of artificial intelligence/machine learning in improving diagnostic accuracy by combining complex variables via various imaging modalities must be researched.

In conclusion, the advancement in focal liver lesion characterization with the use of multi parametric imaging signifies a major leap towards better accuracy in characterizing the lesion, reducing inter-observer variability in the assessment of such lesions, and possibly reducing the need for invasive procedures while enabling the early diagnosis and treatment of the lesion in the event of a pathological condition.

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