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Diagnostic Accuracy of Diffusion Weighted MRI in Differentiating Malignant from Benign Liver Lesions Taking Histopathology as Gold Standard

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ABSTRACT

Background & Objective: Liver lesions are common, and distinguishing between malignant and benign types is crucial. Histopathology, the gold standard, is invasive and costly. DW MRI, a promising non-invasive alternative, requires further research to confirm its diagnostic accuracy in liver lesion differentiation. Objective was to determine the diagnostic accuracy of diffusion weighted MRI in differentiating malignant from benign liver lesions taking histopathology as gold standard.

Methodology: A total of 150 patients meeting inclusion criteria were enrolled from the Department of Diagnostic Radiology, Sir Ganga Ram Hospital, Lahore. Written consent and medical history were obtained, and all underwent diffusion-weighted MRI on a 1.5-T scanner. MRI findings were compared with histopathology for assessing diagnostic accuracy of DW MRI in differentiating liver lesions from benign lesions. Data was analyzed using SPSS 26.0. Sensitivity, specificity, and predictive values were calculated, and results were stratified by age and gender.

Results: The patients had a mean age of 46.77±14.63 years and males were dominant with n=86 (57.3%). Participants aged 18–40 years were 45.3%, while 54.7% were older than 40 years. DW MRI classified 61.3% of lesions as malignant, confirmed as 64.7% by histopathology. Sensitivity, specificity, PPV, NPV, and accuracy were 90.72%, 92.45%, 95.66%, 84.46%, and 98.70%, respectively.

Conclusion: Diffusion-weighted MRI demonstrated higher diagnostic accuracy in differentiating malignant from benign liver lesions while taking histopathology as the gold standard, showing high sensitivity, specificity, and consistent performance across age and gender, supporting its clinical utility

KEY WORDS: Diagnostic Accuracy, Histopathology, Liver Lesions, Sensitivity, Specificity, PPV, NPV.

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INTRODUCTION

The liver is a critical organ in maintaining overall health, but it is increasingly challenged by a variety of diseases where most common conditions are liver lesions affecting 2.5-18% of global population.[1] The lesions may be either simple or complex and may range from benign cyst to malignant tumor inclusive of liver cancer and metastatic lesions. It is vital to detect these lesions at earliest because liver disease remains a significant cause of morbidity and mortality worldwide.[2]

Routine imaging incidentally leads diagnosis of liver lesions especially in asymptomatic patients. Detecting these lesions has significantly improved with the use of advanced imaging techniques i.e. ultrasound, CT, and MRI.[3] However, accurately distinguishing between beingn and malignant lesions is still a challenge, especially when in case of tumors with atypical characteristics. This is particularly true for hepatocellular carcinoma (HCC), where distinguishing primary malignancies from secondary lesions is important to determine appropriate treatment plan.[4]

Usually, ultrasonography (USG) is first imaging modality used for evaluation of liver lesions due to its easy accessibility, low cost, and safety, particularly in terms of avoiding ionizing radiation.[5] When malignancy is suspected, advanced clarification may be sought from computed tomography (CT) scans which provides detailed images and reveals lesion enhancement patterns, though its associated disadvantage is exposure to ionizing radiation.[6] Diffusion-weighted MRI (DW-MRI), within the MRI framework, has emerged as a key imaging technique for liver diagnostics. By assessing the motion of water molecules in tissues, DW-MRI offers both functional and structural insights that other imaging methods may miss.[7,8] Jia et al. reported a sensitivity of 92.3%, specificity of 93.6% of DW MRI.[9]

DW-MRI superseded contrast-enhanced MRI (CE-MRI) since the absence of contrast agents makes it safer and more

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adaptable for liver condition diagnosis.[8] DW-MRI shows growing importance in clinical practice because it combines detailed structural findings and functional information to assist doctors while making treatment plans.[9] New developments in imaging technology require these advances to diagnose liver diseases better while managing liver conditions more effectively so we can lower the worldwide impact of liver-related health problems.[10]

Current literature concerning Diffusion Weighted MRI (DW-MRI) in the differentiation of liver lesions is limited especially the issue of diagnostic accuracy of this tool when compared to histopathology. Despite the fact that DW-MRI has become a promising non-invasive tool, there are still gaps in the literature in the studies assessing its usefulness in differentiating benign and malignant liver lesions. This was to be filled in this study to compare the findings of DW-MRI with the histopathology, to give an analogy of the diagnostic performance of the method. Since the correct classification of liver lesions plays a decisive role in the management of patients and proper planning of treatment, this study was necessary to enhance the ability of diagnosis and beneficial outcomes in liver disease.

METHODOLOGY

This cross-sectional study was conducted over six months in the Department of Diagnostic Radiology, Sir Ganga Ram Hospital, Lahore. A total of 150 patients aged 18 years or older with liver lesions, as per the operational definition, were enrolled using non-probability, consecutive sampling. The sample size was based on previously reported sensitivity (92.3%) and specificity (93.6%) of DW-MRI and prevalence of malignant lesions to be 62.4% at 8% margin of error and 95% confidence level.[9] Inclusion criteria included patients with liver lesions measuring ≥ 1 cm and aged ≥ 18 years. Exclusion criteria were pregnant or breastfeeding women, patients with severe comorbidities, MRI contraindications (e.g., pacemakers, metal implants), or those who did not provide informed written consent. Written informed consent and detailed medical history were obtained from the attendants of each patient. All patients underwent diffusion-weighted MRI on a 1.5-Tesla scanner. Lesions with DW MRI value of less than or equal to $1.5x10^3$ mm^2/cm were labelled as malignant lesions and those with higher values were categorized as benign. The MRI protocol included high b-value DWI sequences and ADC map imaging to assess liver lesions for restricted diffusion and hyper-intensity. Lesion characteristics such as size (≥ 1 cm), ADC values, and other MRI features were noted. The MRI scans were performed by a certified radiologic technologist and interpreted by a single consultant radiologist with ≥ 8 years of experience in abdominal imaging. For each patient, a biopsy or surgical resection was performed, and histopathological examination was conducted by a single experienced histopathologist to confirm the diagnosis. Standardized proforma was used for data collection. Confounding variables were controlled through exclusion criteria. Data analysis was done to determine diagnostic accuracy as per objective of the study. Categorical variables such as the type of malignant liver lesions on DW MRI and histopathology were demonstrated in frequencies and percentages. The diagnostic accuracy of DW MRI was determined according to the given formulas and expressed in frequencies and percentages. The sensitivity, specificity, accuracy, and the positive and negative predictive values of DW MRI were calculated by creating an 2x2 contingency table. Diagnostic accuracy has also been stratified based on age and gender and indivi-dual 2x2 contingency tables have been developed to identify values of diagnostic measures in each of the subgroups.

Table I: Baseline Characteristics of Study Sample

Characteristics	*Participants (n= 150)*
Age (≥ 18years)	46.77±14.63
• 18-40 years	68 (45.3%)
• > 40 years	82 (54.7%)
Gender	
• Male	86 (57.3%)
• Female	64 (42.7%)

RESULTS

The study included 150 participants, all aged 18 years or older, with a mean age of 46.77±14.63 years. Among the participants, 68 (45.3%) were aged between 18 and 40 years, while 82 (54.7%) were older than 40 years. In terms of gender distribution, 86 (57.3%) were male and 64 (42.7%) were female. Data is given in Table I. In DW MRI, 92 lesions (61.3%) were classified as malignant, and 58 lesions (38.7%) were classified as benign, making a total of 150 lesions (100%). In histopathology, 97 lesions (64.7%) were confirmed as malignant, while 53 lesions (35.3%) were benign, again totaling 150 lesions (100%) as shown in Table II. Table III presents the comparison of histopathology-confirmed malignant liver lesions across various subgroups of patients included in the study (n=150) where it had insignificant difference between sub groups of age and gender (p-value>0.05). The diagnostic performance of DW MRI showed excellent sensitivity (90.72%), specificity (92.45%), and overall accuracy (98.70%). The PPV was 95.66%, while the NPV was 84.46% as given in Table IV. Moreover, stratification of diagnostic accuracy for sub groups of age and gender produced similar results for all the sub groups.

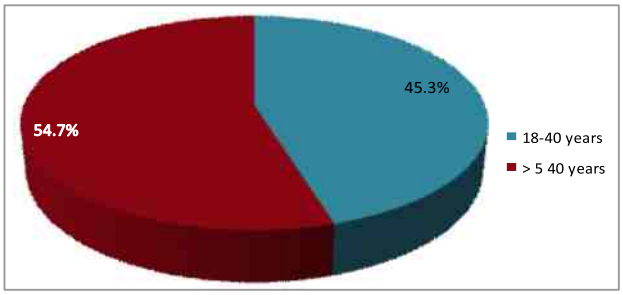

Figure 1: Distribution of Age in the Study Cohort.

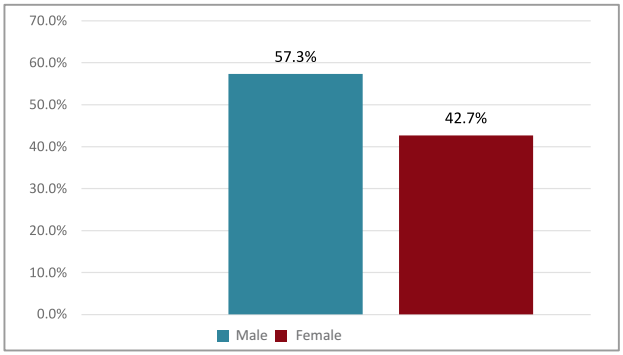

Figure 2: Distribution of Age in the Study Cohort.

DISCUSSION

Liver lesions are common findings in imaging, and accurate differentiation between malignant and benign types is crucial for appropriate management.[11,12] Histopathology is considered the gold standard for diagnosis; however, it is invasive, costly, and not always feasible for all patients. These limitations necessitate search for reliable and non-invasive alternatives.[13,14] DW MRI has emerged as a promising tool due to its ability to assess tissue cellularity and diffusion characteristics. Despite having potential benefits, limited research exists on its diagnostic accuracy compared to histopathology. So this study was planned in local population.

This study included 150 participants aged 18 or older with a mean age of 46.77±14.63 years wherein 57.3% participants were male. Malignant lesions were identified in 92 (61.3%) participants by DW-MRI whereas histopathology confirmed malignant lesions in 97 (64.7%) participants. No significant difference was found across age or gender subgroups. DW MRI showed high diagnostic accuracy with 90.72% sensitivity, 92.45% specificity, 98.70% accuracy, 95.66% PPV, and 84.46% NPV, consistent across all subgroups. Comparison of this study's findings with existing literature shows consistent diagnostic value of DW MR) in differentiating malignant from benign liver lesions. Jia et al. reported a sensitivity of 92.3%, specificity of 93.6%, PPV of 96.0%, NPV

Table II: Frequency of Malignancy of Liver Lesions as per DW MIR and Histopathology

Modality	*Malignant / Benign*	*Frequency (n)*	*Percent (%)*
DW MRI	Malignant	92	61.3%
	Benign	58	38.7%
	Total	150	100.0 %
Histo-pathology	Malignant	97	64.7%
	Benign	53	35.3%
	Total	150	100.0 %

Table III: Comparison of Histopathology Confirmed Malignant Liver Lesions across Various Subgroups of Patients included in the Study n=150

Subgroups	*n*	*Malignant Liver Lesions n (%)*	*p-value*
Age (≥ 18 years)			
• 18-40 years	68	47 (69.1%)	0.299
• > 40 years	82	50 (61.0%)	
Gender			
• Male	86	54 (62.8%)	0.577
• Female	64	43 (67.2%)	

Table IV: 2x2 Contingency Table to Determine Diagnostic Performance of DW MRI in Differentiating Malignant Liver Lesions taking Histopathology as Gold Standard

DW MRI	*Histopathology*		*Total*
	Malignant	*No*	
Malignant	88[a]	4[c]	92
No	9[b]	49[d]	58
Total	97	53	150

[a]True Positive = 88, [c]False Positive = 4, [b]False Negative = 9, [d]True Negative = 49

Statistic	*Formula*	*Value*
Sensitivity	$\frac{a}{a+b}$	90.72%
Specificity	$\frac{d}{c+d}$	92.45%
Accuracy	$\frac{a+d}{a+b+c+d}$	98.70%
Disease prevalence	$\frac{a+b}{a+b+c+d}$	64.70%
Positive Predictive Value	$\frac{a}{a+c}$	95.66%
Negative Predictive Value	$\frac{d}{b+d}$	84.46%

of 88.0%, and a diagnostic accuracy that closely aligns with the current study.[9] Their research also found that the prevalence of malignant lesions in histopathology was 62.4%.[9] Similarly, Latif et al., in an Egyptian study, reported DW MRI's sensitivity at 90.3%, specificity at 78.58%, and a diagnostic accuracy of 86.7%, further supporting the effectiveness of DW MRI in liver lesion diagnosis.[14]

Sharma et al. in India emphasized the use of DWI with ADC quantification as an additional, non-invasive MRI tool to differentiate benign and malignant hepatic lesions. Their study reported a sensitivity of 85.7%, specificity of 88%, PPV of 88%, and NPV of 85.7%, highlighting its potential in clinical settings.[15] Jain et al. in India analyzed 75 liver lesions, including 39 benign and 36 malignant, and found a statistically significant difference in ADC and ADC ratio values ($p < 0.001$). ADC ratio was superior in diagnostic accuracy, with a cutoff of 1.1 yielding 82% sensitivity, 86% specificity, and 92% overall accuracy.[12]

Varigonda et al. also found DWI to be valuable in the evaluation of focal liver lesions, especially for cases where contrast administration is either contraindicated or challenging, such as in uncooperative patients. Their findings underscored the significant advantage of using DWI as a contrast-free imaging method.[16] Lastly, Haradome et al. compared different imaging modalities and reported that the combined set of DWI and T2WI had a higher overall characterization accuracy (80.3%) compared to T2WI alone (68.8%) and DWI alone (73.2%). While the combined set was significantly more accurate for characterizing lesions, there was no significant difference between T2WI and DWI alone.[17]

Limitations

A fairly large sample size, high diagnostic accuracy and consistency of diagnostic accuracy across sub groups of age and gender are strengths of this study. But limitation is reliance on histopathology as gold standard, which is invasive toll. Moreover, absence of long-term follow-up data is also a limitation. Future research should focus on further validating DW MRI across diverse populations, exploring its role in early detection, and evaluating its potential in routine clinical practice without need for invasive procedures.

CONCLUSION

DW MRI non-invasively and effectively differentiated malignant from benign liver lesions, showing high sensitivity, specificity, and accuracy. Its diagnostic performance remained consistent across different age and gender groups, highlighting its reliability and potential as a valuable clinical tool for liver lesion evaluation and early diagnosis.

Ethical Approval: Ethical Review Committee Fatima Jinnah Medical University, Lahore allowed vide letter No.102/ C/ ERB dated 03-10-2025.

Conflict of Interest: None

Financial Disclosure: None

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Authors' Contributions:

ZM, SC: Conceptualization & study design.

KS, HAB: Data Collection and manuscript drafting.

VA, SN: Data Analysis and critical review, Supervision & Manuscript drafting & proof reading.

All authors have read and approved the final version of the manuscript and are responsible and accountable for the accuracy and integrity of the work

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