

DIAGNOSTIC ACCURACY OF NON-CONTRAST MAGNETIC RESONANCE IMAGING IN THE CHARACTERIZATION OF FEMALE PELVIC MASSES: CORRELATION WITH HISTOPATHOLOGY

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ABSTRACT

Background: Accurate characterization of female pelvic masses is essential for appropriate clinical management. MRI provides superior soft-tissue characterization, while diffusion-weighted imaging may improve differentiation between benign and malignant lesions. This study evaluated the diagnostic performance of non-contrast MRI using histopathology as the reference standard. **Materials and Methods:** A prospective observational study was conducted in 84 female patients with clinically suspected or ultrasonographically detected pelvic masses. All patients underwent 3-Tesla non-contrast MRI, including T1-weighted, T2-weighted, STIR, and diffusion-weighted sequences with ADC maps. Lesions were assessed for site, morphology, signal characteristics, margins, diffusion restriction, and associated findings. MRI diagnoses were correlated with postoperative histopathology. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, and Cohen's kappa were calculated. **Result:** Ovarian lesions were the most frequent masses (53.6%), followed by uterine lesions (31.0%). Cystic masses predominated (47.6%), while diffusion restriction was identified in 21.4% of patients. Histopathology demonstrated 61 (72.6%) benign and 23 (27.4%) malignant lesions. Non-contrast MRI correctly identified 19 malignant and 57 benign lesions, with 4 false-positive and 4 false-negative classifications. Sensitivity was 82.6%, specificity 93.4%, PPV 82.6%, NPV 93.4%, and diagnostic accuracy 90.5%. Agreement with histopathology was substantial ($\kappa=0.76$; $p<0.001$). **Conclusion:** Non-contrast MRI demonstrated good diagnostic accuracy and substantial agreement with histopathology for characterization of female pelvic masses. Its combination of morphological assessment and diffusion-weighted imaging may provide a useful non-invasive approach when contrast-enhanced MRI is contraindicated or unavailable.

INTRODUCTION

Female pelvic masses encompass a broad spectrum of benign, borderline, and malignant conditions arising from the uterus, ovaries, fallopian tubes, cervix, and other pelvic structures. Accurate characterization of these lesions is essential because imaging findings directly influence decisions regarding surveillance, surgical intervention, referral to gynecologic oncology, and fertility-preserving management. Although ultrasonography, particularly transvaginal ultrasonography, remains the first-line imaging modality for evaluation of adnexal masses, a substantial proportion of lesions remain indeterminate on ultrasound because of complex morphology, hemorrhage, solid components, or uncertain organ of origin.^[1,2] Magnetic resonance

imaging (MRI) provides superior soft-tissue contrast and multiplanar capability and is therefore an important problem-solving modality for further characterization of indeterminate pelvic and adnexal masses.^[3,4]

Conventional MRI sequences, including T1- and T2-weighted imaging, provide valuable information regarding tissue composition, hemorrhage, fat, fibrous tissue, fluid content, lesion morphology, and anatomic relationships. Diffusion-weighted imaging (DWI) provides additional functional information regarding tissue cellularity and can be particularly useful in differentiating benign from malignant lesions. Quantitative assessment using the apparent diffusion coefficient (ADC) may further improve lesion characterization by identifying areas of restricted diffusion associated with increased

cellularity.^[5,6] Recent evidence indicates that DWI demonstrates good diagnostic performance for differentiating benign and malignant ovarian lesions, although variation in acquisition protocols and ADC thresholds remains an important consideration.^[7] Standardized MRI-based risk stratification systems have further improved the reproducibility of adnexal mass assessment. The ADNEX MR scoring system was developed to categorize adnexal lesions according to their likelihood of malignancy and demonstrated high sensitivity and specificity in its initial validation.^[8] Subsequent external validation and prospective multicenter studies have confirmed its diagnostic performance and reproducibility, supporting the role of structured MRI interpretation in clinical practice.^[9,10] The Ovarian-Adnexal Reporting and Data System for MRI (O-RADS MRI) was subsequently developed by an international multidisciplinary group to provide standardized terminology and risk stratification for adnexal lesions.^[11] Meta-analytic evidence has demonstrated high diagnostic performance of MRI-based O-RADS assessment, with pooled sensitivity and specificity of approximately 92% and 91%, respectively, for differentiating benign from malignant indeterminate adnexal lesions.^[12]

Importantly, most existing evidence has focused predominantly on adnexal or ovarian masses and frequently incorporates dynamic contrast-enhanced MRI. However, contrast administration may be contraindicated or undesirable in certain patients because of renal dysfunction, previous adverse reactions, pregnancy-related considerations, or other clinical circumstances. Consequently, there is increasing interest in determining whether a non-contrast MRI protocol incorporating conventional sequences and diffusion-weighted imaging can provide sufficient diagnostic information for pelvic mass characterization. Emerging studies suggest that O-RADS MRI assessment based on non-dynamic contrast-enhanced MRI, particularly when combined with ADC measurements, may retain substantial diagnostic accuracy and reproducibility.^[13] Nevertheless, direct correlation of non-contrast MRI findings with definitive histopathological diagnosis across the spectrum of female pelvic masses remains clinically relevant.

Histopathological examination remains the definitive reference standard for establishing the nature and subtype of surgically resected pelvic masses. Correlating MRI morphology and diffusion characteristics with histopathology can therefore help identify imaging features associated with specific benign and malignant entities and determine the diagnostic capability of a non-contrast MRI approach. The present study was consequently undertaken to characterize pelvic masses in female patients using non-contrast MRI, correlate the imaging findings with histopathological diagnoses, and determine the sensitivity and specificity of non-

MATERIALS AND METHODS

Study Design and Participants: This prospective observational study was conducted in the Department of Radiodiagnosis, National Institute of Medical Sciences & Research Centre, Jaipur, over a period of 18 months. Female patients of all age groups presenting with clinically suspected or ultrasonographically detected pelvic masses and referred from the outpatient and inpatient departments of various clinical specialties were considered for inclusion. Patients fulfilling the predefined eligibility criteria were recruited using consecutive sampling.

The required sample size was calculated using the formula $n = Z^2 P(1-P)/d^2$, where Z was 1.96 for a 95% confidence level, P was the expected prevalence of 94.2%, and d was the absolute precision of 5%. The calculated sample size was 83.95, which was rounded to 84 patients.

Patients were eligible if they were female, belonged to any age group, and had a pelvic mass detected clinically and/or on ultrasonography. Patients with absolute contraindications to MRI, including non-MRI-compatible implanted devices, severe claustrophobia precluding MRI examination, or unwillingness to participate, were excluded.

MRI Technique and Image Interpretation: All participants underwent non-contrast MRI of the pelvis using a 3-Tesla MRI system. The imaging protocol consisted of axial and sagittal T1-weighted spin-echo sequences; axial, sagittal, and coronal T2-weighted sequences; and short-tau inversion recovery (STIR) sequences. Diffusion-weighted imaging (DWI) was acquired using b values of 0, 500, and 1000 s/mm², with corresponding apparent diffusion coefficient (ADC) maps generated for assessment of diffusion characteristics. No intravenous gadolinium-based contrast agent was administered.

MRI examinations were evaluated for the site of origin, lesion size, morphology, internal architecture, signal characteristics, diffusion restriction, and local extension. Lesions were categorized as predominantly solid, cystic, or mixed based on their morphology. T1- and T2-weighted signal characteristics, STIR signal behaviour, and diffusion restriction were assessed. Additional imaging features including septations, papillary projections, fat, hemorrhagic components, and evidence of local invasion or adjacent organ involvement were documented.

The MRI diagnosis was established based on the combined assessment of morphological and signal characteristics. The radiological diagnosis was subsequently compared with the definitive histopathological diagnosis.

Histopathological Correlation: Patients who underwent surgical excision or biopsy of the pelvic lesion were included for histopathological correlation. Resected tissue specimens were

processed using standard histopathological techniques and examined by an experienced pathologist following hematoxylin and eosin (H&E) staining. Histopathology was considered the reference standard for definitive classification of lesions as benign or malignant and, where applicable, for establishing the specific histological diagnosis. The final MRI diagnosis was correlated with the histopathological findings to determine the ability of non-contrast MRI to correctly characterize pelvic masses and differentiate benign from malignant lesions. MRI findings were classified as true positive, true negative, false positive, or false negative according to the histopathological reference diagnosis.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS statistical software. Continuous variables were summarized using appropriate measures of central tendency and dispersion, while categorical variables were expressed as frequencies and percentages. The diagnostic performance of non-contrast MRI was assessed using sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy, with histopathological examination considered the reference standard. Diagnostic parameters were calculated from the corresponding 2×2 contingency tables. A p value <0.05 was considered statistically significant, wherever applicable.

RESULTS

The study included 84 female patients with pelvic masses. As shown in [Table 1], the largest proportion of patients belonged to the 41–50-year age group (33.3%), while pelvic pain was the most common presenting complaint (50.0%). [Table 2] demonstrates that the ovary was the most frequent site of pelvic mass origin (53.6%), with cystic lesions being the predominant morphological type (47.6%). [Table 3] shows that non-contrast MRI correctly identified 19 malignant and 57 benign lesions, with four false-positive and four false-negative cases. As presented in [Table 4], non-contrast MRI demonstrated a sensitivity of 82.6%, specificity of 93.4%, and overall diagnostic accuracy of 90.5%, with substantial agreement with histopathology ($\kappa=0.76$; $p<0.001$).

Regarding the graphical findings, [Figure 1] shows that most patients were premenopausal, with 38.1% having regular and 35.7% having irregular menstrual cycles. [Figure 2] demonstrates that single pelvic lesions were slightly more common than multiple lesions (54.8% vs. 45.2%). In [Figure 3], ascites and lymphadenopathy were identified in 21.4% and 19.0% of patients, respectively. [Figure 4] demonstrates that diffusion restriction was considerably more frequent among malignant lesions than benign lesions, supporting its potential role as an important MRI feature for identifying malignancy.

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristic	Frequency, n (%)
Age group (years)	
20–30	6 (7.1)
31–40	16 (19.0)
41–50	28 (33.3)
51–60	20 (23.8)
>60	14 (16.7)
Chief complaint	
Pelvic pain	42 (50.0)
Pelvic mass	18 (21.4)
Abdominal mass/distension	10 (11.9)
Abnormal uterine bleeding	9 (10.7)
Other complaints	5 (6.0)

Table 2: MRI Characteristics of Pelvic Masses

MRI characteristic	Frequency, n (%)
Site of origin	
Ovary	45 (53.6)
Uterus	26 (31.0)
Cervix	8 (9.5)
Adnexa	5 (6.0)
Morphological type	
Cystic	40 (47.6)
Solid	28 (33.3)
Mixed	16 (19.0)
Margin	
Well-defined	58 (69.0)
Ill-defined	26 (31.0)

Table 3: Cross-tabulation of Non-contrast MRI Diagnosis and Histopathological Diagnosis

MRI diagnosis	Histopathologically malignant	Histopathologically benign	Total
MRI malignant	19 (TP)	4 (FP)	23
MRI benign	4 (FN)	57 (TN)	61
Total	23	61	84

TP, true positive; TN, true negative; FP, false positive; FN, false negative.

Table 4: Diagnostic Performance of Non-contrast MRI for Differentiating Benign and Malignant Pelvic Masses

Diagnostic parameter	Estimate
Sensitivity	82.6%
Specificity	93.4%
Positive predictive value	82.6%
Negative predictive value	93.4%
Overall diagnostic accuracy	90.5%
Cohen's kappa	0.76
p-value	<0.001

Calculations:

- Sensitivity = $19/(19+4) = 82.6\%$
- Specificity = $57/(57+4) = 93.4\%$
- PPV = $19/(19+4) = 82.6\%$
- NPV = $57/(57+4) = 93.4\%$
- Accuracy = $(19+57)/84 = 90.5\%$

The equal PPV and sensitivity, and equal NPV and specificity, occur because the MRI-positive and MRI-negative totals happen to equal the histopathological malignant and benign totals, respectively.

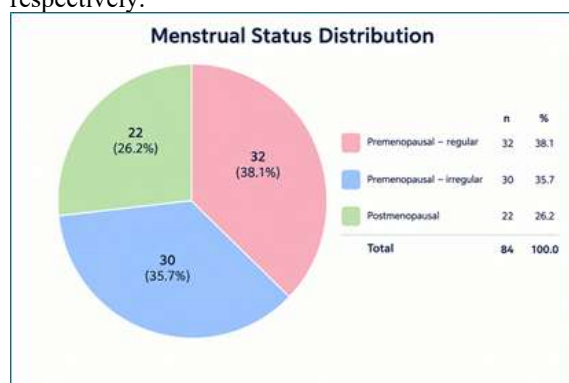


Figure 1: Menstrual Status of the Study Population

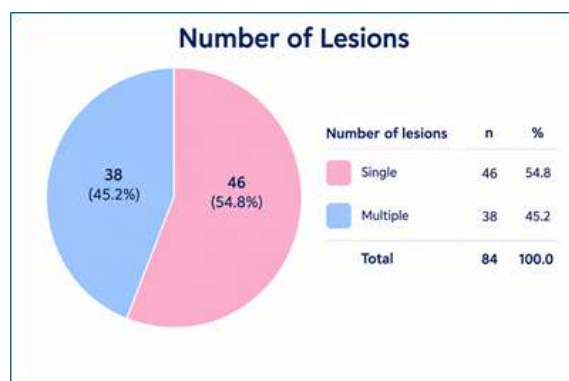


Figure 2: Number of Pelvic Lesions



Figure 3: Associated MRI Findings: Ascites and Lymphadenopathy

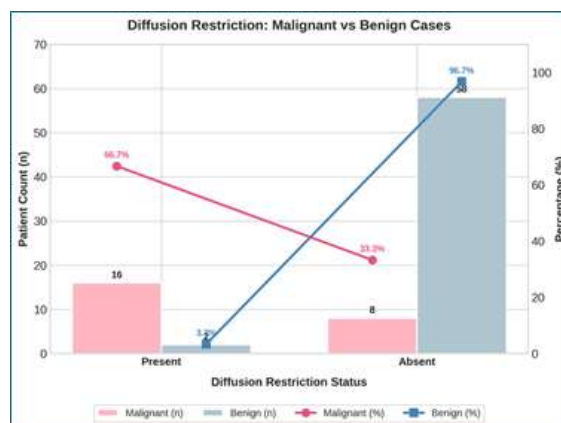


Figure 4: Diffusion Restriction According to Histopathological Category

DISCUSSION

The present prospective study evaluated the diagnostic performance of non-contrast magnetic resonance imaging (MRI) in 84 female patients with clinically suspected or ultrasonographically detected pelvic masses, using histopathology as the reference standard. The study demonstrated that non-contrast MRI achieved a sensitivity of 82.6%, specificity of 93.4%, and overall diagnostic accuracy of 90.5%, with substantial agreement with histopathological diagnosis ($\kappa=0.76$; $p<0.001$). These findings support the clinical utility of MRI-based morphological and diffusion characteristics for distinguishing benign from malignant pelvic masses, particularly when tissue characterization is required beyond the capabilities of ultrasonography.

The distribution of lesions in the present study was consistent with the recognized predominance of adnexal and ovarian pathology among female pelvic masses. Ovarian lesions represented the largest anatomical group (53.6%), followed by uterine lesions (31.0%), cervical lesions (9.5%), and other adnexal lesions (6.0%). Griffin et al. emphasized that accurate identification of the organ of origin and systematic assessment of lesion morphology are fundamental to the characterization of adnexal masses.^[1] Similarly, Forstner et al. highlighted MRI as an important problem-solving modality for sonographically indeterminate adnexal masses because of its superior soft-tissue contrast and ability to characterize tissue composition, vascularity, and local extension.^[3] The predominance of ovarian lesions in our cohort therefore reflects the clinical

spectrum in which MRI is particularly valuable, although the inclusion of uterine and cervical masses broadens the applicability of the present findings beyond an exclusively adnexal population.

Cystic morphology was the most frequent MRI pattern in the present study (47.6%), followed by solid (33.3%) and mixed solid-cystic masses (19.0%). Most lesions were well defined (69.0%), whereas 31.0% demonstrated ill-defined margins. These findings reinforce the importance of integrating multiple morphological parameters rather than relying on a single imaging feature. Wang et al. described the importance of standardized assessment of adnexal cystic morphology and emphasized that many apparently complex or incidental cystic lesions can be confidently stratified when imaging morphology is interpreted in conjunction with established risk-classification frameworks.^[2] Forstner et al. similarly recommended systematic evaluation of lesion architecture, signal characteristics, internal components, and surrounding structures when assessing indeterminate adnexal masses.^[3] In this context, the present study demonstrates that even without contrast enhancement, a structured assessment of lesion morphology can provide clinically meaningful information.

Diffusion-weighted imaging (DWI) represented an important component of the non-contrast MRI protocol in the present study. Diffusion restriction was observed in 18 patients (21.4%) and was considerably more frequent among malignant lesions than benign lesions. This observation is biologically plausible because increased cellularity and reduced extracellular space in many malignant tumors can result in restricted water diffusion and reduced apparent diffusion coefficient (ADC) values. Hottat et al. demonstrated that incorporation of DWI and ADC information improves the assessment of adnexal masses and provides additional diagnostic information beyond conventional MRI morphology.^[5] Eftekhari Moghadam et al. likewise demonstrated the value of DWI-based assessment in differentiating benign and malignant ovarian lesions, supporting diffusion characteristics as an important imaging biomarker of malignancy.^[12] More recently, Pugliesi et al, in a systematic review and meta-analysis, reported strong overall diagnostic performance of DWI for ovarian malignancy, further supporting the role of diffusion imaging as a non-invasive tissue-characterization technique.^[6] The present findings are therefore concordant with the broader evidence that diffusion information can strengthen malignancy assessment without requiring gadolinium administration.

The diagnostic performance observed in our study is also broadly consistent with the evolution of MRI-based risk stratification systems for adnexal masses. Thomassin-Naggara et al. developed the ADNEX MR scoring system to provide a structured approach to differentiating benign from malignant adnexal masses, demonstrating that combinations of MRI

features are more informative than isolated findings.^[7] Pereira et al. subsequently demonstrated that a simplified MRI protocol could retain substantial diagnostic accuracy, suggesting that comprehensive contrast-enhanced protocols may not always be necessary for clinically useful lesion characterization.^[8] Basha et al. further confirmed the validity and reproducibility of the ADNEX MR approach, emphasizing the importance of standardized interpretation in reducing diagnostic variability.^[9] Although the present study did not directly apply the ADNEX MR score, its high specificity (93.4%) and accuracy (90.5%) support the broader principle that systematic interpretation of MRI morphology and tissue characteristics can provide reliable discrimination between benign and malignant pelvic masses.

The O-RADS MRI framework has further established the importance of standardized MRI-based risk stratification. Thomassin-Naggara et al. developed the O-RADS MRI score specifically to stratify sonographically indeterminate adnexal masses and demonstrated that MRI can provide a reproducible framework for estimating the likelihood of malignancy.^[10] The present study differs from the O-RADS MRI approach because it used a non-contrast protocol and incorporated a broader group of pelvic masses rather than focusing exclusively on sonographically indeterminate adnexal lesions. Nevertheless, the diagnostic performance achieved in our cohort—particularly the high specificity and substantial histopathological agreement—suggests that selected non-contrast MRI features may provide useful preoperative risk information. This may be particularly relevant in settings where contrast administration is contraindicated, undesirable, or not routinely available.

The present findings also compare favorably with the broader diagnostic literature evaluating MRI for female pelvic pathology. Haringa et al. highlighted the diagnostic role of MRI in female pelvic disease and demonstrated its value relative to other cross-sectional and ultrasound-based imaging approaches.^[11] Sakala et al. described the expanding role of modern pelvic MRI techniques, including high-resolution anatomical imaging and diffusion-weighted sequences, for comprehensive characterization of female pelvic pathology.^[4] More recently, Salman et al. evaluated gynecological mass lesions using MRI with histopathological correlation, reinforcing the value of MRI for preoperative characterization and pathological correlation.^[13] The 90.5% diagnostic accuracy observed in the present study, together with a κ value of 0.76, indicates substantial concordance between imaging diagnosis and definitive histopathology and supports MRI as a clinically meaningful intermediate step between initial detection and tissue diagnosis.

The relatively higher specificity than sensitivity observed in our cohort is clinically relevant. A specificity of 93.4% indicates that most benign masses were correctly identified as non-malignant,

potentially reducing unnecessary oncological referral or overly aggressive surgical planning for lesions with reassuring imaging characteristics. Conversely, the sensitivity of 82.6% indicates that a proportion of malignant lesions may not demonstrate sufficiently overt imaging features to permit confident malignant classification on non-contrast MRI alone. This distinction is important because absence of marked diffusion restriction or aggressive morphology should not be interpreted as definitive exclusion of malignancy. The results therefore support the use of non-contrast MRI as a strong characterization and triage tool rather than as a universal replacement for contrast-enhanced MRI or histopathological examination.

The use of histopathology as the reference standard strengthens the validity of the present diagnostic estimates. Unlike studies evaluating MRI findings without definitive tissue confirmation, the present analysis directly assessed concordance between imaging classification and pathological diagnosis. The observed positive predictive value of 82.6% and negative predictive value of 93.4% further indicate that a benign MRI classification was associated with a high probability of benign histopathology in this cohort. However, these predictive values should be interpreted in relation to the 27.4% prevalence of malignancy in the study population and should not be extrapolated directly to populations with substantially different disease prevalence.

Limitations: This study has several limitations. First, the sample size was relatively modest (n=84), and the study was conducted at a single tertiary-care center, which may limit generalizability. Second, the study included heterogeneous pelvic masses involving the ovary, uterus, cervix, and adnexa; therefore, the diagnostic estimates may not be directly comparable with studies restricted to sonographically indeterminate adnexal masses. Third, the MRI protocol was non-contrast, precluding assessment of enhancement kinetics and vascularity, which are important components of established O-RADS MRI and ADNEX MR algorithms.^[7,9,10] Fourth, histopathological verification was available for surgically evaluated lesions, introducing the possibility of selection or verification bias. Finally, the study did not perform external validation or interobserver reproducibility assessment. Larger multicentric studies incorporating standardized scoring systems, ADC measurements, and independent radiologist assessment are warranted to validate the diagnostic performance of non-contrast MRI across diverse pelvic mass populations.

CONCLUSION

Non-contrast MRI demonstrated good diagnostic performance for characterization of female pelvic masses, with high specificity, satisfactory sensitivity, and substantial agreement with histopathology. The combination of conventional morphological

assessment and diffusion-weighted imaging provided useful discrimination between benign and malignant lesions without the need for gadolinium administration. These findings support non-contrast MRI as a valuable non-invasive imaging modality for preoperative characterization and risk assessment of pelvic masses, particularly when contrast-enhanced MRI is contraindicated or unavailable. Larger multicentric studies with standardized MRI scoring systems and quantitative ADC assessment are warranted to validate these findings.

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