

Role of USG and MRI in the Diagnostic Assessment of Adnexal Masses**Abhishek Mishra¹, Agami Bhowmick²**¹Consultant Radiologist, Department of Radiology, Ex Sr in IPGMER SSKM Hospital, Now in Private Diagnostic Centre Sonoscan, India²Senior Resident, Malda Medical College and Hospital, Department of Obstetrics and Gynaecology, Malda Medical College and Hospital West Bengal, India

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Abstract:

Background: Adnexal masses represent a diverse group of gynecological conditions ranging from benign cysts to malignant neoplasms. Accurate preoperative characterization is crucial for guiding appropriate management and avoiding unnecessary surgical intervention. Ultrasonography (USG) serves as the initial diagnostic tool, while magnetic resonance imaging (MRI) offers superior soft tissue resolution for indeterminate or complex lesions. Integrating both imaging modalities enhances diagnostic confidence and assists in differentiating benign from malignant adnexal masses.

Aim: To evaluate and compare the diagnostic accuracy of ultrasonography and magnetic resonance imaging in assessing adnexal masses and to correlate their findings with histopathological examination as the gold standard.

Methods: This prospective study included 44 female patients with clinically or sonographically suspected adnexal masses. All participants underwent detailed USG evaluation followed by MRI examination. Imaging parameters such as morphology, vascularity, septations, wall nodules, ascites, and enhancement patterns were recorded. The imaging findings were correlated with histopathological outcomes, and statistical analysis was performed to determine sensitivity, specificity, and diagnostic accuracy for each modality.

Results: The mean age of patients was 47.5 ± 7.7 years, with the majority (40.9%) belonging to the 41–50-year group. Histopathology revealed 28 benign (63.6%) and 16 malignant (36.4%) lesions. On USG, 75% of lesions were cystic and 25% were solid-cystic, while MRI detected 70.5% cystic and 29.5% solid-cystic lesions. USG showed a sensitivity of 100%, specificity of 81.3%, and diagnostic accuracy of 93.2%, whereas MRI demonstrated superior specificity (87.5%) and diagnostic accuracy (95.4%). Features such as solid-cystic morphology, mural nodules, ascites, and enhancement patterns on MRI were statistically significant predictors of malignancy ($p < 0.001$).

Conclusion: Ultrasonography remains an excellent first-line modality for evaluating adnexal masses due to its high sensitivity and accessibility. However, MRI provides greater specificity and superior soft tissue characterization, making it indispensable in complex or indeterminate cases. The combined use of USG and MRI ensures the most accurate preoperative differentiation between benign and malignant lesions.

Recommendations: MRI should be routinely employed as a complementary modality to USG in evaluating complex or inconclusive adnexal masses. Establishing standardized MRI-based scoring systems such as O-RADS MRI can further enhance diagnostic reliability and guide surgical planning.

Keywords: Adnexal mass, Ultrasonography, Magnetic resonance imaging, Histopathology, Diagnostic accuracy.

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Introduction

Adnexal masses are among the most frequently encountered gynecologic pathologies, encompassing a wide spectrum of benign and malignant conditions that arise from the ovary, fallopian tube, or adjacent connective tissues. Accurate preoperative characterization of these masses is essential for determining appropriate management, as benign lesions often require conservative or minimally invasive approaches, whereas malignant ones necessitate radical surgery or oncologic referral [1]. The increasing availability

of advanced imaging modalities has greatly improved diagnostic precision, allowing clinicians to differentiate between benign and malignant adnexal lesions with greater confidence.

(USG) remains the primary imaging modality for the initial evaluation of adnexal masses due to its accessibility, cost-effectiveness, and lack of ionizing radiation [2]. The use of high-resolution transvaginal sonography has enhanced diagnostic accuracy by providing detailed morphological assessment, including lesion size, internal

architecture, septations, and vascularity through Doppler studies [3]. However, despite these advantages, sonographic interpretation can sometimes be limited, particularly in cases of indeterminate or complex masses, where features overlap between benign and malignant entities. In such scenarios, (MRI) serves as an indispensable adjunct, offering superior soft tissue contrast and multiplanar capabilities [4].

MRI plays a crucial role in further characterizing indeterminate adnexal lesions identified on USG. It allows detailed evaluation of internal components, wall irregularities, and enhancement patterns after contrast administration, thereby improving the specificity in detecting malignancy [5]. Studies in recent years have emphasized the utility of MRI-based scoring systems such as the ADNEX MR or O-RADS MRI score, which provide standardized and reproducible assessments of malignancy risk [6]. The addition of diffusion-weighted imaging (DWI) and dynamic contrast-enhanced sequences further refines lesion characterization by revealing microstructural and perfusion differences between benign and malignant tissues [7].

Given the significant overlap of imaging features among various adnexal pathologies, integrating the diagnostic strengths of both USG and MRI offers a comprehensive approach to patient evaluation. This combined assessment enhances diagnostic confidence, aids in preoperative surgical planning, and helps avoid unnecessary interventions. The present study aims to evaluate the diagnostic utility of ultrasonography and magnetic resonance imaging in the assessment of adnexal masses, comparing their efficacy in differentiating benign and malignant lesions with histopathological correlation as the gold standard.

Materials and Methods

Study Design and Setting: This was a hospital-based, prospective observational study carried out in the Department of Radiology and the Department of Obstetrics & Gynaecology at IPGME&R and SSKM Hospital, Kolkata. The study was conducted over a period of 17 months, from February 2020 to July 2021.

Study Population and Sample Size: The study included 44 female patients who either presented to the Gynaecology outpatient department with suspicion of adnexal lesions, had adnexal space-occupying lesions (SOL) detected incidentally on ultrasonography, or were admitted as diagnosed cases of adnexal SOL.

Inclusion Criteria

- Female patients presenting with abdominal pain suspected of adnexal SOL.

- Patients with incidentally detected adnexal SOL on USG.
- Indoor patients admitted as cases of ovarian SOL.
- Patients presenting with menstrual irregularities.

Exclusion Criteria

- Patients unwilling to participate.
- Patients with known allergy to MRI contrast agents.
- Patients with metallic implants incompatible with MRI.
- Claustrophobic patients.
- Male patients.
- Pregnant patients.

Data Collection: A structured proforma was used to record patient details. Relevant clinical history, examination findings, and investigation results were documented.

Clinical and Radiological Parameters

- **Clinical data** included age, religion, contact details, and duration of illness.
- **Biochemical investigations** included serum urea and creatinine.
- **Radiological assessment:**
 - (USG): Used to study tumor morphology, presence of ascites, vascularity, and internal septations.
 - (MRI): Evaluated lesion size, morphology, local spread, extent, and lymph node involvement.

Histopathological examination (HPE) findings were later correlated with USG and MRI results.

Study Tools and Imaging Protocols

- **Equipment:** A 3.0 Tesla MRI scanner (GE Healthcare) and a Philips HD7 revision 3.0 USG machine were used.
- **MRI Protocol:** Patients fasted for 4 hours before scanning to reduce bowel peristalsis artifacts. A phased-array coil was used. Imaging included T1-weighted, T2-weighted (axial, sagittal, coronal), fat-suppressed T1/T2 sequences, (DWI), and post-contrast fat-suppressed gradient echo T1-weighted images.
- **USG Protocol:** Transabdominal sonography was performed with a full bladder, and transvaginal sonography with an empty bladder. Fasting was not required.

Ethical Considerations: Ethical approval for the study was obtained from the Institutional Ethics Committee before initiation.

Statistical Analysis: Data were entered in Microsoft Excel and analyzed using SPSS version 27.0 and

GraphPad Prism version 5. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical data were presented as counts and percentages. Independent sample t-tests and paired t-tests were applied for numerical data, and Chi-

square or Fisher's exact tests were used for categorical comparisons. A p-value ≤ 0.05 was considered statistically significant.

Results and Analysis

Table 1: Demographic Profile of Study Population (n=44)

Parameter	Subgroup	Frequency	Percentage (%)	Statistical Summary
Age (years)	31–40	11	25.0	Mean = 47.5 $\pm$ 7.7 (33–65 years)
	41–50	18	40.9	Median = 48 years
	>50	15	34.1	
Laterality	Unilateral	32	72.7	
	Bilateral	12	27.3	

Most patients (40.9%) were aged between 41–50 years, indicating a perimenopausal predominance. The mean age was 47.5 years. The majority (72.7%)

had unilateral adnexal lesions, while bilateral involvement was observed in 27.3%.

Table 2: Ultrasonographic Morphological Characteristics (n=44)

USG Feature	Category	Frequency	Percentage (%)	Statistical Result (Chi-square, p-value)
Morphology	Cystic	33	75.0	p < 0.0001
	Solid-Cystic	11	25.0	
Ascites	Present	8	18.2	p < 0.0001
	Absent	36	81.8	
Vascularity	Absent	26	59.1	p < 0.0001
	Central	12	27.3	
	Peripheral	6	13.6	
Lesion Type (USG)	Benign	31	70.5	p < 0.0001
	Malignant	13	29.5	

On USG, 75% of lesions appeared cystic, and ascites was present in 18.2% of cases. Central vascularity (27.3%) and mixed morphology were significantly

correlated with malignancy (p<0.0001). Overall, USG identified 70.5% lesions as benign and 29.5% as malignant.

Table 3: MRI Morphological and Enhancement Characteristics (n=44)

MRI Feature	Category	Frequency	Percentage (%)	Statistical Result
Morphology	Cystic	31	70.5	p < 0.0001
	Solid-Cystic	13	29.5	
Wall Nodule	Present	5	11.4	p = 0.0016
	Absent	39	88.6	
Ascites	Present	6	13.6	p = 0.0004
	Absent	38	86.4	
Enhancement Pattern	No enhancement	28	63.6	p < 0.0001
	Septal enhancement	10	22.7	
	Solid enhancement	6	13.6	
Omental Deposits	Present	2	4.5	p = 0.055
Lymph Node Enlargement	Present	2	4.5	p = 0.055

MRI revealed solid-cystic morphology in 29.5% and wall nodules in 11.4%, both strongly associated with malignancy. Contrast enhancement, especially septal and solid patterns, was significant in

differentiating benign from malignant lesions (p<0.0001). Omental deposits and nodal involvement, though infrequent, trended toward malignancy.

Table 4: Histopathological Examination (HPE) Findings (n=44)

HPE Result	Category	Frequency	Percentage (%)
Overall Diagnosis	Benign	28	63.6
	Malignant	16	36.4
Benign Lesions	Serous cystadenoma	17	38.6
	Mucinous cystadenoma	9	20.5
	Dermoid cyst	1	2.3
	Endometrioma	1	2.3
Malignant Lesions	Serous cystadenocarcinoma	11	25.0
	Mucinous cystadenocarcinoma	5	11.4

Histopathology confirmed benign lesions in nearly two-thirds (63.6%) and malignancy in 36.4% of cases. Serous cystadenoma was the most frequent

benign type (38.6%), while serous cystadenocarcinoma dominated malignant lesions (25%).

Table 5: Comparison of USG and MRI with HPE

Imaging Modality	Benign by HPE	Malignant by HPE	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
USG	28	16	100.0	81.3	90.3	100.0	93.2
MRI	28	16	100.0	87.5	93.3	100.0	95.4

Both USG and MRI demonstrated high sensitivity (100%) for detecting malignant adnexal lesions. However, MRI outperformed USG in specificity

(87.5% vs. 81.3%) and diagnostic accuracy (95.4% vs. 93.2%), emphasizing MRI's superiority in confirming malignancy.

Table 6: Statistical Correlation Between Imaging Features and HPE

Imaging Parameter	Statistical Test	p-Value	Interpretation
Bilateral involvement	$\chi^2 = 15.73$	<0.0001	Significant correlation with malignancy
USG Morphology	$\chi^2 = 25.67$	<0.0001	Significant
Ascites on USG	$\chi^2 = 17.11$	<0.0001	Significant
Vascularity pattern	$\chi^2 = 38.23$	<0.0001	Highly significant
MRI Morphology	$\chi^2 = 32.29$	<0.0001	Significant
Wall nodule on MRI	$\chi^2 = 9.87$	0.0016	Significant
Ascites on MRI	$\chi^2 = 12.16$	0.0004	Significant
Enhancement pattern	$\chi^2 = 44.0$	<0.0001	Highly significant
Omental deposits	$\chi^2 = 3.66$	0.055	Not significant
Lymph node	$\chi^2 = 3.66$	0.055	Not significant

Most USG and MRI features showed strong statistical significance in differentiating malignant from benign lesions. Vascularity, ascites, and

enhancement patterns were the most predictive parameters ($p < 0.0001$).

Table 7: Mean Morphometric Parameters

Variable	Mean $\pm$ SD	Range	Median
Age (years)	47.5 $\pm$ 7.7	33–65	48.0
Septal Thickness (USG, mm)	2.71 $\pm$ 1.20	1.1–4.6	3.2
Septal Characteristics (MRI, mm)	2.41 $\pm$ 1.16	1.0–4.7	1.95

The mean septal thickness was higher on USG (2.7 mm) than on MRI (2.4 mm), consistent with MRI's better resolution in defining thin septations.

Morphometric differences aided in identifying borderline and malignant patterns.

Table 8: Correlation of Age with HPE Diagnosis

Age Group	Benign (n=28)	Malignant (n=16)	p-Value
31–40 years	7 (25.0%)	4 (25.0%)	
41–50 years	12 (42.9%)	6 (37.5%)	
>50 years	9 (32.1%)	6 (37.5%)	0.924 (NS)

There was no significant correlation between age and histopathological diagnosis ($p=0.924$). Both

benign and malignant lesions were common in the 41–50 year range.

Table 9: Correlation of Laterality and Morphology with Malignancy

Parameter	Benign (%)	Malignant (%)	p-Value	Odds Ratio
Bilateral Lesions	7.1	62.5	<0.0001	0.046
Solid-Cystic Morphology	0.0	68.8	<0.0001	–
Cystic Morphology	100.0	31.3	<0.0001	–

Bilateral and solid-cystic adnexal masses were significantly associated with malignancy

($p<0.0001$). Unilateral, simple cystic morphology favored benign etiology.

Table 10: Overall Diagnostic Performance of USG and MRI

Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	Predictive Value	Remarks
USG	100	81.3	93.2	PPV = 90.3%, NPV = 100	First-line modality; high sensitivity
MRI	100	87.5	95.4	PPV = 93.3%, NPV = 100	Superior specificity and tissue differentiation
HPE (Gold Standard)	–	–	–	Confirmatory	Final diagnostic reference

Both imaging techniques showed excellent sensitivity, but MRI demonstrated superior specificity and diagnostic precision, making it an invaluable adjunct when USG findings are equivocal.

Summary of Findings:

- Most adnexal masses occurred in women aged 41–50 years.
- USG accurately detected 93% of lesions, while MRI achieved 95% diagnostic accuracy.
- Solid-cystic morphology, central vascularity, ascites, septal enhancement, and bilateral involvement were the strongest indicators of malignancy.
- MRI remains the gold standard imaging modality following USG for indeterminate adnexal lesions.

Discussion

The present study included forty-four female patients with clinically or sonographically suspected adnexal masses who underwent detailed evaluation by ultrasonography and magnetic resonance imaging, followed by histopathological confirmation. The ages of the patients ranged from 33 to 65 years, with a mean age of 47.5 ± 7.7 years. Most patients belonged to the 41–50-year age group, indicating that adnexal lesions were most common in perimenopausal women. Unilateral involvement was observed in 72.7% of cases, whereas bilateral lesions were found in 27.3% and were significantly associated with malignancy.

Ultrasonography revealed that 75% of lesions were cystic and 25% were solid-cystic in appearance. Ascites was detected in 18.2% of patients, and the vascularity pattern showed no flow in 59.1%, central

vascularity in 27.3%, and peripheral vascularity in 13.6% of cases. Based on ultrasonographic features, 70.5% of lesions were categorized as benign and 29.5% as malignant. Features such as solid-cystic morphology, central vascularity, and the presence of ascites were statistically significant predictors of malignancy with p-values less than 0.0001. The mean septal thickness on USG was 2.7 ± 1.2 mm, and thicker septations, mural nodules, or internal vascularity were suggestive of malignant potential. Although USG demonstrated high sensitivity in detecting adnexal masses, it sometimes lacked specificity in differentiating benign from malignant lesions, particularly in complex or indeterminate cases.

MRI evaluation showed that 70.5% of the lesions were cystic and 29.5% were solid-cystic. Wall nodules were identified in 11.4% of cases, and ascites was present in 13.6%. In terms of contrast enhancement, 63.6% of lesions showed no enhancement, 22.7% showed septal enhancement, and 13.6% demonstrated solid enhancement. Septal and solid enhancement patterns were strongly associated with malignancy, with a p-value of less than 0.0001. Omental deposits and lymphadenopathy were detected in 4.5% of cases each, both indicating malignant potential though without reaching statistical significance. The mean septal characteristic on MRI was 2.4 ± 1.1 mm, confirming the superior ability of MRI to define thin septations, wall irregularities, and internal components. MRI proved particularly valuable in characterizing complex adnexal masses and identifying features suggestive of malignancy such as mural nodules, irregular walls, and post-contrast enhancement patterns.

Histopathological examination confirmed 28 benign (63.6%) and 16 malignant (36.4%) lesions. Among the benign lesions, serous cystadenoma was most common (38.6%), followed by mucinous cystadenoma (20.5%), while dermoid cyst and endometrioma each accounted for 2.3%. Among malignant lesions, serous cystadenocarcinoma was predominant (25%) followed by mucinous cystadenocarcinoma (11.4%). This histological distribution correlated well with the imaging findings, indicating that most adnexal masses in this study were of epithelial origin.

When correlated with histopathological findings, ultrasonography showed a sensitivity of 100%, specificity of 81.3%, positive predictive value of 90.3%, negative predictive value of 100%, and an overall diagnostic accuracy of 93.2%. MRI showed comparable sensitivity of 100% but better specificity (87.5%), positive predictive value (93.3%), and diagnostic accuracy (95.4%). These findings indicate that MRI was more specific and accurate than USG in differentiating benign from malignant adnexal masses, especially in cases where USG findings were equivocal.

Statistical analysis further revealed that parameters such as bilaterality, solid-cystic morphology, ascites, vascularity on USG, wall nodules, and enhancement on MRI were all significantly associated with malignancy ($p < 0.001$). Age did not show any significant correlation with the nature of the lesion ($p = 0.924$), though the perimenopausal age group had the highest prevalence. Omental deposits and lymph node enlargement, although not statistically significant, were observed primarily in malignant cases and reflected disease progression.

Overall, the study demonstrated that ultrasonography remains the most valuable initial imaging modality for screening adnexal lesions due to its accessibility, affordability, and high sensitivity. However, MRI provided superior contrast resolution, tissue characterization, and spatial delineation, making it an essential problem-solving tool in indeterminate cases. The presence of solid-cystic components, thick septations, mural nodules, contrast enhancement, ascites, and bilateral involvement were strong indicators of malignancy. Combining the two modalities yielded the most reliable preoperative evaluation, facilitating accurate differentiation between benign and malignant adnexal lesions and ensuring appropriate clinical management.

Recent evidence-based studies from 2018 onwards have highlighted the complementary roles of ultrasound (USG) and magnetic resonance imaging (MRI) in the evaluation of adnexal masses. MRI has been shown to significantly enhance diagnostic accuracy when ultrasound results are inconclusive. Ghavami et al. reported that MRI provides superior

tissue characterization, allowing better differentiation between benign and malignant adnexal masses [8]. Similarly, Thomassin-Naggara et al. found that MRI offers improved diagnostic performance in cases where ultrasound findings are ambiguous, supporting its role as a valuable adjunct imaging modality [9]. Despite the advantages of MRI, transvaginal ultrasound remains the first-line imaging technique due to its accessibility, cost-effectiveness, and high sensitivity. Kinkel et al. emphasized the utility of ultrasound, particularly when used alongside scoring systems such as the International Ovarian Tumor Analysis (IOTA) Simple Rules, which further refine diagnostic accuracy [10]. The combination of ultrasound and MRI has been shown to yield optimal diagnostic performance. Yasmin et al. demonstrated that integrating these two modalities improves sensitivity and specificity for distinguishing benign from malignant adnexal lesions compared to either technique alone, highlighting their complementary nature [11]. MRI-based scoring systems, such as O-RADS, have further strengthened malignancy risk prediction. Thomassin-Naggara et al. validated the O-RADS MRI scoring system, showing high sensitivity and specificity, with strong agreement with histopathologic findings, thus enhancing clinical decision-making [9]. Recent studies continue to support the role of MRI as an adjunct to ultrasound. A prospective study by Siddhartha et al. found that MRI provided superior accuracy in characterizing ovarian lesions compared to ultrasound alone, reinforcing its importance in cases where malignancy is suspected or ultrasound findings are inconclusive [12]. Collectively, these studies suggest that while ultrasound should remain the initial imaging modality for adnexal masses, MRI is a powerful complementary tool that improves diagnostic confidence, facilitates risk stratification, and may reduce unnecessary surgical interventions.

Conclusion

Ultrasonography is an excellent screening tool for adnexal masses, while MRI offers superior specificity and accuracy in differentiating benign from malignant lesions. Combined use of both modalities ensures precise diagnosis, with MRI serving as an essential adjunct in complex or indeterminate cases.

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