Research Article

The Role of Magnetic Resonance Imaging and Ultrasonography in Ovarian-Adnexal Reporting and Data System (O-Rads) For Patients Presenting With Adnexal Masses and Its Correlation With Histopathology

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Abstract

Background: Adnexal masses comprise a heterogeneous spectrum of benign, borderline and malignant lesions, making accurate preoperative characterization essential for appropriate management. Ultrasonography is the primary imaging modality, while magnetic resonance imaging (MRI) provides additional characterization of indeterminate lesions. The Ovarian-Adnexal Reporting and Data System (O-RADS) provides standardized risk stratification for both ultrasound and MRI.

Methods: This hospital-based cross-sectional observational study included 50 women aged >18 years presenting with adnexal masses. All participants underwent standardized transabdominal and transvaginal ultrasonography followed by pelvic MRI. Lesions were categorized according to O-RADS USG and O-RADS MRI criteria. Histopathology was considered the reference standard wherever surgical intervention was performed. Diagnostic performance was assessed using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy.

Results: Histopathology demonstrated 36 (72%) benign, 4 (8%) borderline and 10 (20%) malignant lesions. O-RADS USG classified 32 (64%) lesions as low risk (O-RADS 2–3) and 18 (36%) as intermediate/high risk (O-RADS 4–5). O-RADS USG demonstrated 90% sensitivity, 78% specificity, 72% PPV, 92% NPV and 82% accuracy. O-RADS MRI classified 30 (60%) lesions as low risk and 20 (40%) as intermediate/high risk. MRI demonstrated superior diagnostic performance, with 95% sensitivity, 92% specificity, 86% PPV, 97% NPV and 94% accuracy. MRI improved specificity by 14 percentage points and overall accuracy by 12 percentage points compared with USG. All O-RADS 2 lesions were benign on both modalities. The combined O-RADS assessment showed 92% concordance with histopathology, with 8% discordance.

Conclusion: O-RADS ultrasonography provides effective first-line risk stratification of adnexal masses, demonstrating high sensitivity and negative predictive value. O-RADS MRI provides additional diagnostic value, particularly by improving specificity and overall accuracy in indeterminate or suspicious lesions. A sequential USG followed by MRI when clinically indicated approach can improve preoperative characterization, risk stratification and surgical planning, with strong correlation between combined imaging assessment and histopathology.

Keywords: Adnexal Mass; O-RADS; Ultrasonography; Magnetic Resonance Imaging; Ovarian Neoplasms; Diagnostic Accuracy; Histopathology; Risk Stratification; Sensitivity; Specificity.

Introduction

Adnexal masses represent a heterogeneous group of gynecological lesions arising from the ovaries, fallopian tubes, and surrounding pelvic structures. Their spectrum ranges from functional and benign cystic lesions to borderline tumors and clinically aggressive malignancies. Because these entities may demonstrate overlapping clinical and imaging features, accurate preoperative characterization is essential for appropriate management, avoidance of unnecessary surgery, and timely referral of patients with suspected malignancy. Standard radiological references emphasize the complex morphological and pathological spectrum of adnexal lesions and the importance of differentiating benign from malignant disease before definitive treatment [1,2].

Imaging plays a central role in the evaluation of adnexal masses. Ultrasonography is generally used as the first-line imaging modality because it is widely available, relatively inexpensive, provides real-time assessment, does not involve ionizing radiation, and permits detailed evaluation of lesion morphology and vascularity. Transabdominal and transvaginal approaches can demonstrate important features such as cystic or solid composition, septations,

papillary projections, wall characteristics and Doppler vascularity [3,4]. Doppler assessment can additionally provide information regarding vascular patterns within a lesion, which may contribute to assessment of neoplastic potential [5].

Despite these advantages, conventional ultrasound assessment can be limited by operator dependence and by the substantial morphological overlap between benign and malignant adnexal lesions. Complex masses may therefore remain indeterminate, resulting in variation in radiological interpretation and uncertainty regarding follow-up, referral or surgical management. To improve consistency, the American College of Radiology (ACR) Ovarian-Adnexal Reporting and Data System (O-RADS) introduced standardized terminology and structured ultrasound-based risk stratification. The O-RADS US framework classifies adnexal lesions according to defined morphological features and links imaging categories with clinical management recommendations, thereby facilitating more uniform communication between radiologists and treating clinicians [6].

Magnetic resonance imaging (MRI) has an important complementary role, particularly when ultrasound findings are indeterminate. MRI provides superior soft-tissue contrast and additional functional information through diffusion-weighted imaging and contrast-enhanced sequences. The O-RADS MRI system incorporates lesion morphology, signal characteristics, diffusion restriction and enhancement behavior into a structured risk-stratification framework, with categories ranging from O-RADS MRI 1 to O-RADS MRI 5 and progressively increasing risk of malignancy [7,8]. O-RADS MRI therefore extends the information obtained from ultrasound and provides a standardized approach to problem-solving in sonographically indeterminate lesions.

The development of O-RADS MRI represents an important transition from predominantly subjective interpretation toward standardized, reproducible and management-oriented imaging assessment. Its principal clinical value lies in its ability to further characterize lesions that cannot be confidently categorized using ultrasound alone. Structured MRI assessment incorporates morphological and functional parameters, including signal intensity, diffusion characteristics and enhancement patterns, thereby improving characterization of complex adnexal masses and supporting appropriate clinical decision-making [8,9]. The intended workflow is therefore complementary: ultrasonography acts as the initial screening and risk-stratification modality, while MRI provides additional characterization when lesions remain indeterminate or suspicious [9].

The need for reliable risk stratification is particularly important because the consequences of misclassification are substantial. Overestimation of malignancy may result in unnecessary surgery or extensive oncological procedures for benign lesions, whereas underestimation may delay appropriate oncological referral and definitive treatment. Comparative evaluation of structured systems has demonstrated that O-RADS performs favourably against alternative approaches such as GI-RADS and IOTA Simple Rules in the assessment of malignancy risk in adnexal masses [10]. Thus, integrating standardized O-RADS US and O-RADS MRI assessment has the potential to improve diagnostic confidence while maintaining an appropriate balance between avoiding unnecessary intervention and identifying lesions requiring definitive management.

The clinical relevance of this structured approach is further supported by the findings of the present study. Among 50 women with adnexal masses, histopathological examination demonstrated that 36 (72%) lesions were benign, 4 (8%) were borderline and 10 (20%) were malignant. On O-RADS US, 64% of lesions were categorized as low risk (O-RADS 2–3), whereas 36% were categorized as intermediate/high risk (O-RADS 4–5). O-RADS MRI classified 60% as low risk and 40% as intermediate/high risk.

Importantly, O-RADS US demonstrated 90% sensitivity, 78% specificity, 72% positive predictive value, 92% negative predictive value and 82% overall accuracy, while O-RADS MRI demonstrated 95% sensitivity, 92% specificity, 86% positive predictive value, 97% negative predictive value and 94% overall accuracy. MRI therefore improved specificity by 14 percentage points and overall accuracy by 12 percentage points compared with ultrasound. The combined O-RADS assessment showed 92% concordance with histopathology, supporting the potential value of a tiered ultrasound-to-MRI imaging strategy for comprehensive evaluation of adnexal masses.

METHODOLOGY

This hospital-based cross-sectional observational study was conducted in the Department of Radio-Diagnosis and Imaging in collaboration with the Departments of Obstetrics and Gynaecology and Pathology at a tertiary care teaching hospital over a period of 18 months. The study included 50 female patients aged >18 years presenting with clinically suspected adnexal masses and referred for radiological evaluation. A purposive consecutive sampling technique was used, with eligible patients recruited consecutively until the required sample size was achieved. The

minimum calculated sample size was 47, based on an anticipated correlation coefficient of 0.35, 95% confidence level and 80% power, and was rounded to 50 patients to account for possible exclusions or incomplete histopathological correlation. Patients with suspected adnexal masses, including those with inconclusive or indeterminate initial ultrasound findings requiring MRI characterization, were included after informed consent. Patients with MRI-incompatible implants, pregnancy, very small lesions unsuitable for O-RADS categorization, prior bilateral oophorectomy, or unwillingness to participate were excluded.

All enrolled patients underwent standardized transabdominal and transvaginal ultrasonography, followed by pelvic MRI for further characterization. The adnexal lesions were assessed systematically and assigned appropriate O-RADS US and O-RADS MRI categories based on their morphological, signal, diffusion and enhancement characteristics. MRI was particularly used for further evaluation of lesions that remained indeterminate or suspicious on ultrasound. Histopathological examination of surgically excised lesions was considered the reference standard and was performed by experienced pathologists using routine hematoxylin and eosin staining. The imaging-based O-RADS classifications were subsequently correlated with histopathological diagnosis to assess concordance and diagnostic performance.

The primary analysis compared the diagnostic performance of O-RADS USG and O-RADS MRI for differentiating benign, borderline and malignant adnexal lesions. Diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated, and the imaging classifications were compared with histopathological findings. The study also assessed the degree of agreement between the combined O-RADS assessment and histopathology.

RESULTS:

TABLE 1. Baseline Clinical Profile of Study Participants (n=50)

Variable	Category	n	%
Age	≤20 years	4	8.0
	21–30 years	16	32.0
	31–40 years	14	28.0
	41–50 years	10	20.0
	>50 years	6	12.0
Clinical presentation	Pain abdomen	38	76.0
	Palpable mass	6	12.0
	Menstrual irregularity	4	8.0
	Incidental finding	2	4.0
Laterality	Right	26	52.0
	Left	20	40.0
	Bilateral	4	8.0

Key finding: The largest age group was 21–30 years (32%), followed by 31–40 years (28%); together they constituted 60% of participants. Abdominal pain was the predominant presentation (76%), and right-sided lesions were most frequent (52%).

TABLE 2. Morphological and O-RADS Distribution on USG and MRI

Assessment	Category	USG n (%)	MRI n (%)
Morphology	Unilocular cystic	14 (28.0)	14 (28.0)
	Multilocular cystic	16 (32.0)	15 (30.0)
	Cystic with solid component	12 (24.0)	11 (22.0)
	Predominantly solid	8 (16.0)	10 (20.0)
O-RADS category	O-RADS 2	14 (28.0)	16 (32.0)
	O-RADS 3	18 (36.0)	14 (28.0)
	O-RADS 4	10 (20.0)	10 (20.0)
	O-RADS 5	8 (16.0)	10 (20.0)

Risk grouping	Low risk: O-RADS 2–3	32 (64.0)	30 (60.0)
	Intermediate/high risk: O-RADS 4–5	18 (36.0)	20 (40.0)

Key finding: Multilocular cystic morphology was the commonest pattern on both modalities. MRI identified a slightly greater proportion of predominantly solid lesions (20% vs 16%). USG classified 64% as O-RADS 2–3, while MRI classified 60% as O-RADS 2–3, with MRI showing a greater proportion in O-RADS 5.

TABLE 3. O-RADS USG and MRI Correlation With Histopathology

O-RADS category	USG: Benign	Borderline	Malignant	MRI: Benign	Borderline	Malignant
O-RADS 2	14	0	0	16	0	0
O-RADS 3	16	2	0	13	1	0
O-RADS 4	4	2	4	5	2	3
O-RADS 5	2	0	6	2	1	7

Histopathological reference distribution

Histopathological diagnosis	n	%
Benign	36	72.0
Borderline	4	8.0
Malignant	10	20.0

Important category-wise findings:

- **USG O-RADS 2:** 100% benign.
- **USG O-RADS 3:** 88.9% benign, 11.1% borderline, no malignancy.
- **USG O-RADS 4:** 40% benign, 20% borderline, 40% malignant.
- **USG O-RADS 5:** 75% malignant.
- **MRI O-RADS 2:** 100% benign.
- **MRI O-RADS 3:** 92.9% benign, 7.1% borderline, no malignancy.
- **MRI O-RADS 4:** 50% benign, 20% borderline, 30% malignant.
- **MRI O-RADS 5:** 70% malignant.

TABLE 4. Comparative Diagnostic Performance of O-RADS USG and MRI

Diagnostic parameter	O-RADS USG	O-RADS MRI	MRI improvement
Sensitivity	90%	95%	+5 percentage points
Specificity	78%	92%	**+14 percentage points**
PPV	72%	86%	+14 percentage points
NPV	92%	97%	+5 percentage points
Overall accuracy	82%	94%	**+12 percentage points**

Interpretation: Both modalities demonstrated high sensitivity, but MRI showed clearly better specificity, PPV, NPV and overall accuracy. The largest gain was in specificity, increasing from 78% with USG to 92% with MRI, indicating fewer benign lesions being incorrectly classified as suspicious.

TABLE 5. Clinical Management and Overall Imaging–Histopathology Concordance

Outcome	n	%
Laparoscopic cystectomy	22	44.0

Laparotomy	12	24.0
Staging laparotomy	10	20.0
Conservative management	6	12.0
Total	**50**	**100**
Combined O-RADS concordant with histopathology	46	**92.0**
Combined O-RADS discordant with histopathology	4	**8.0**

Overall finding: Laparoscopic cystectomy was the most frequent management approach (44%), while 12% were managed conservatively. Combined O-RADS USG + MRI demonstrated **92% concordance with histopathology**, with only 8% discordance.

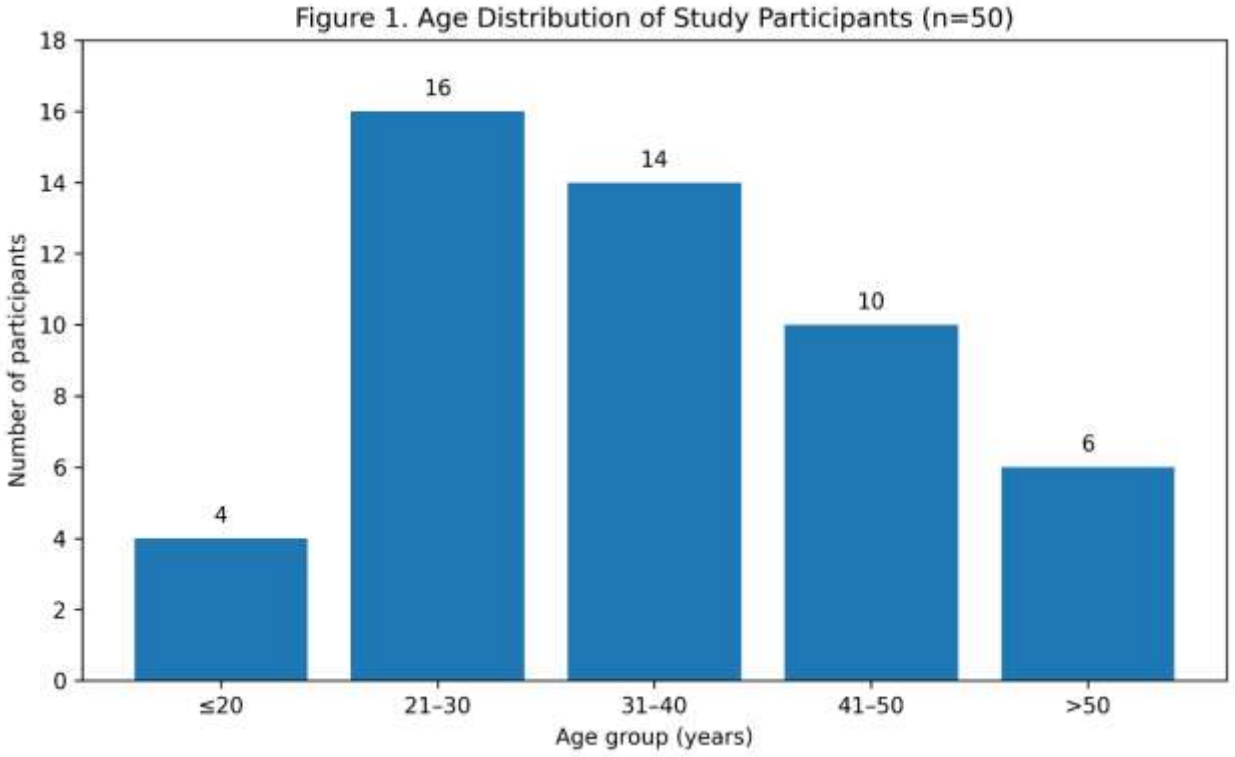


Figure 2. O-RADS Category Distribution: USG vs MRI (n=50)

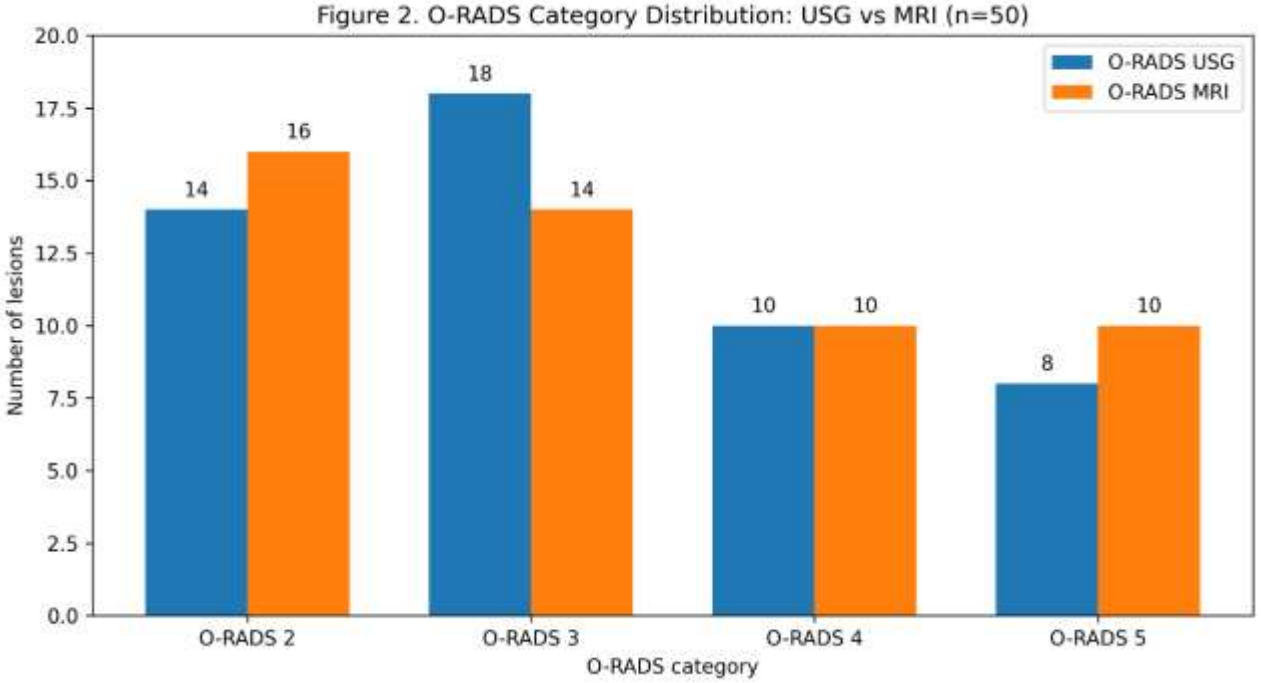
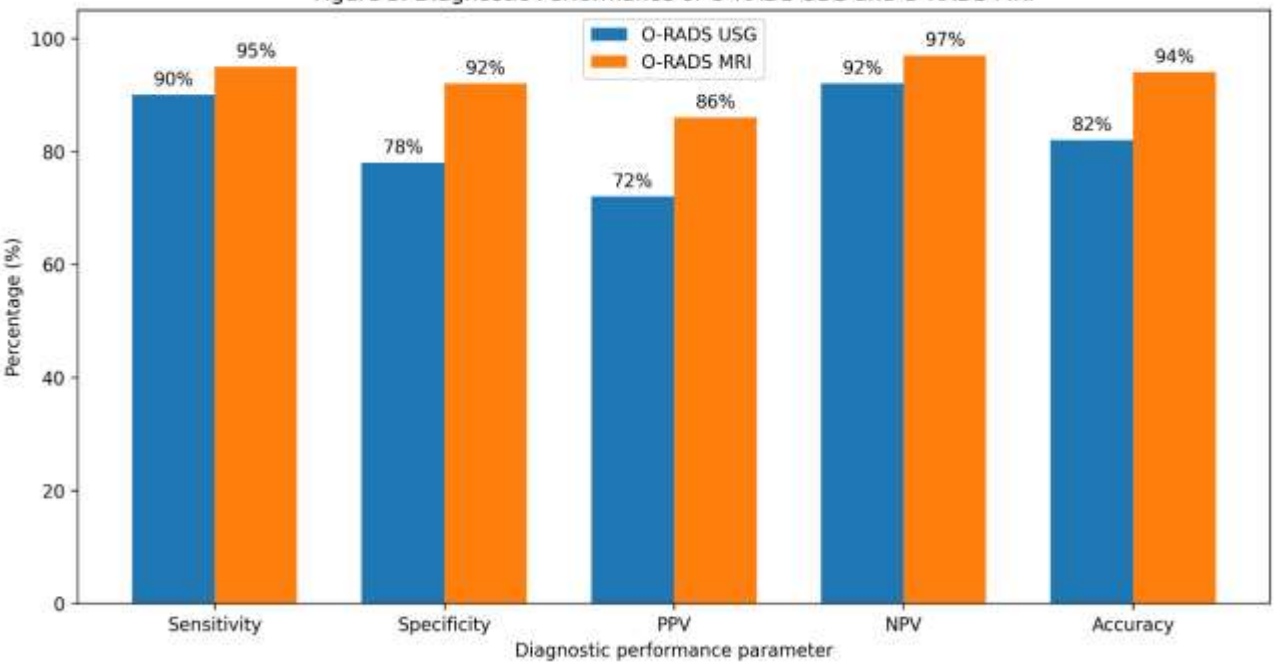


Figure 3. Diagnostic Performance of O-RADS USG and O-RADS MRI



DISCUSSION

The present study evaluated the diagnostic performance of O-RADS ultrasonography and O-RADS MRI in 50 women with adnexal masses, with histopathology serving as the reference standard wherever surgical intervention was performed. Histopathological examination demonstrated 36 (72%) benign lesions, 4 (8%) borderline tumors and 10 (20%) malignant lesions. On O-RADS USG, 64% of lesions were classified as low risk (O-RADS 2–3), while 36% were classified as intermediate/high risk (O-RADS 4–5). On O-RADS MRI, 60% were categorized as low risk and 40% as

intermediate/high risk. Patel-Lippmann et al. [11] emphasized that O-RADS US and O-RADS MRI have complementary roles in the evaluation of adnexal lesions, with MRI providing additional characterization when ultrasound findings remain indeterminate. The present findings support this sequential approach.

The present study showed that the largest proportion of participants belonged to the 21–30-year age group (32%), followed by 31–40 years (28%), while abdominal pain was the predominant clinical presentation (76%). Takkar et al. [12] evaluated O-RADS classification in relation to histopathology and demonstrated that increasing O-RADS category was associated with increasing likelihood of malignant pathology. Their findings support the clinical relevance of structured risk categorization in patients presenting with adnexal masses.

With regard to lesion morphology, multilocular cystic lesions were the most frequent pattern, accounting for 32% on USG and 30% on MRI. Unilocular cystic lesions accounted for 28% on both modalities, while predominantly solid lesions constituted 16% on USG and increased to 20% on MRI. Siddhartha et al. [13] similarly highlighted the complementary role of ultrasonography and MRI in morphological assessment of ovarian lesions. The slightly greater identification of predominantly solid lesions on MRI in the present study may reflect the superior soft-tissue characterization of MRI.

The distribution of O-RADS categories demonstrated a clear relationship between increasing imaging category and pathological risk. On USG, all O-RADS 2 lesions were benign, while 88.9% of O-RADS 3 lesions were benign and none were malignant. In O-RADS 4, 40% were malignant, while 75% of O-RADS 5 lesions were malignant. On MRI, all O-RADS 2 lesions were benign, 92.9% of O-RADS 3 lesions were benign, 30% of O-RADS 4 lesions were malignant and 70% of O-RADS 5 lesions were malignant. Andreotti et al. [14] developed the O-RADS US risk-stratification and management system to standardize lesion description, assign malignancy risk and guide clinical management. The progressive increase in malignant pathology across higher O-RADS categories in the present study supports the usefulness of this structured system.

Accurate preoperative characterization of ovarian and adnexal tumors is essential because the distinction between benign, borderline and malignant lesions directly influences referral, surgical planning and the extent of surgery. Timmerman et al. [15] emphasized standardized preoperative diagnosis as an important component of appropriate management of ovarian tumors. In the present study, the ability of O-RADS to stratify lesions into different risk categories provided clinically useful information before definitive histopathological diagnosis.

O-RADS USG demonstrated 90% sensitivity, 78% specificity, 72% PPV, 92% NPV and 82% overall accuracy. Cao et al. [16], in a large validation study of 1,054 adnexal masses, demonstrated excellent diagnostic performance of O-RADS US and reported malignancy rates of approximately 0.45% for O-RADS 2, 1.10% for O-RADS 3, 34.46% for O-RADS 4 and 89.57% for O-RADS 5. The very low malignancy rates in O-RADS 2–3 and marked increase in malignancy in O-RADS 4–5 are consistent with the risk gradient observed in the present study, although the absolute proportions differ because of differences in sample size and disease spectrum.

Pereira et al. [18] assessed the performance of O-RADS MRI in adnexal masses and reported 91.11% sensitivity, 94.92% specificity, 89.13% PPV, 95.90% NPV and 93.73% accuracy. In the present study, O-RADS MRI demonstrated 95% sensitivity, 92% specificity, 86% PPV, 97% NPV and 94% accuracy. Thus, the overall accuracy in our study was remarkably similar to that reported by Pereira et al., with the present study showing slightly higher sensitivity and NPV but slightly lower specificity and PPV.

Su et al. [19] also demonstrated high diagnostic efficacy of O-RADS for differentiating benign and malignant adnexal masses, supporting the value of standardized O-RADS assessment over subjective evaluation alone. In the present study, the high NPV of both modalities—92% for USG and 97% for MRI—is particularly important clinically, as it indicates a strong ability to identify lesions unlikely to be malignant and may help reduce unnecessary aggressive intervention.

The most important improvement observed with MRI was in specificity. Specificity increased from 78% with USG to 92% with MRI, representing an absolute improvement of 14 percentage points. PPV increased from 72% to 86%, NPV from 92% to 97%, and overall accuracy from 82% to 94%. Sadowski et al. [20] described O-RADS MRI as an important problem-solving tool following initial ultrasound, particularly for adnexal lesions that remain indeterminate after sonographic evaluation. The present findings strongly support this role of MRI, as its greatest contribution was improved specificity and overall diagnostic confidence.

The MRI results in the present study are also consistent with the findings of Kılıçkap [21], whose systematic review and meta-analysis demonstrated high pooled diagnostic performance for O-RADS MRI in differentiating benign from borderline or malignant adnexal lesions. The specificity of approximately 90% reported in the meta-analysis is close

to the 92% specificity observed in the present study, while the sensitivity of 95% in our cohort was also within the range reported in the pooled evidence. This concordance strengthens the validity of the present MRI findings.

Strachowski et al. [22] described the updated O-RADS US v2022 system, with refinements in lesion descriptors and risk categorization intended to improve consistency and management recommendations. This is particularly relevant to the present study because multilocular cystic lesions and lesions containing solid components constituted a substantial proportion of the cohort. MRI provided additional characterization in these morphologically complex lesions, supporting the complementary use of the two modalities.

Dabi et al. [23] described O-RADS MRI as a practical system developed specifically to address the clinical problem of sonographically indeterminate adnexal masses. The present study demonstrates the clinical relevance of this concept: MRI increased PPV from 72% to 86%, NPV from 92% to 97%, specificity from 78% to 92%, and overall accuracy from 82% to 94%. Thus, MRI contributed not only to detection but also to more confident characterization and risk stratification of adnexal lesions.

The role of MRI as a problem-solving modality for indeterminate adnexal masses has also been supported by Spencer et al. [24], who proposed an algorithmic MRI approach for sonographically indeterminate adnexal lesions. The present findings are consistent with this approach, with USG providing effective first-line evaluation and MRI adding diagnostic information when lesions require further characterization. This sequential strategy avoids the need for MRI as the initial examination in every patient while providing a more specific modality when ultrasound alone is insufficient.

Yaman et al. [25] demonstrated the importance of reproducibility and standardized measurement techniques in gynecological ultrasonography. Although their study addressed three-dimensional ultrasound assessment rather than O-RADS classification of adnexal masses, the principle of standardized imaging acquisition remains relevant to the present study. Structured acquisition and interpretation are important for minimizing operator-dependent variability and improving consistency of O-RADS categorization.

The clinical relevance of the imaging findings is further demonstrated by the management pattern in the present cohort. Laparoscopic cystectomy was performed in 44%, laparotomy in 24%, staging laparotomy in 20% and conservative management in 12%. The predominance of laparoscopic cystectomy corresponds with the predominance of benign lesions, whereas staging laparotomy was undertaken in patients with lesions requiring oncological management.

A particularly important finding was the 92% concordance between combined O-RADS USG/MRI assessment and histopathology, with only 8% discordance. This high concordance indicates that the complementary use of ultrasound and MRI can provide reliable preoperative risk stratification. The findings are consistent with the concept described by Patel-Lippmann et al. [11], in which O-RADS US and O-RADS MRI are integrated as complementary rather than competing imaging systems.

CONCLUSION

The present study demonstrates that O-RADS ultrasonography and O-RADS MRI provide effective and complementary approaches for risk stratification of adnexal masses. Among 50 women, histopathology showed 72% benign, 8% borderline and 20% malignant lesions. O-RADS USG demonstrated high sensitivity (90%) and negative predictive value (92%), supporting its role as an effective first-line imaging modality. O-RADS MRI showed superior diagnostic performance, with sensitivity of 95%, specificity of 92%, PPV of 86%, NPV of 97% and overall accuracy of 94%. Compared with USG, MRI improved specificity by 14 percentage points and accuracy by 12 percentage points, particularly enhancing characterization of indeterminate and suspicious lesions. The combined O-RADS assessment demonstrated 92% concordance with histopathology. Therefore, a sequential imaging strategy using O-RADS USG followed by O-RADS MRI when required can improve diagnostic confidence, facilitate appropriate surgical planning, and potentially reduce unnecessary interventions in patients with benign adnexal masses.

LIMITATIONS

The present study has several limitations. First, the study included a relatively small sample of 50 patients, which may limit the statistical power and generalizability of the findings to larger and more diverse populations. Second, the study was conducted at a single tertiary-care centre, and the patient spectrum may therefore differ from that encountered in community or other healthcare settings. Third, histopathological confirmation was available where

surgical intervention was performed; therefore, lesions managed conservatively may not have had definitive tissue confirmation. Fourth, the study included benign, borderline and malignant lesions, and the relatively small number of borderline and malignant cases may have influenced category-specific diagnostic performance estimates. Fifth, imaging interpretation may be influenced by operator and reader experience, particularly with ultrasound. Finally, the study evaluated diagnostic performance within the available study period and did not assess long-term clinical outcomes or follow-up of conservatively managed lesions. Larger multicentric prospective studies with standardized interpretation and longer follow-up are therefore required to validate these findings.

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