DOI:10.55095/CesRadiol2025/028 Ces Radiol 2025; 79(4): 317–326

original article

O-RADS MRI score for assessment of adnexal masses

O-RADS MR skóre v hodnocení adnexálních nádorů

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Accepted: 8. 9. 2025

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Conflict of interest: none.

This study was conducted in accordance with the ethical standards of the institutional research committee of Ain Shams University and with the 1964 Helsinki Declaration and its later amendments. All patients provided informed consent prior to participation.

The study involved non-invasive imaging only, and confidentiality of all participants' medical data was strictly maintained.

The authors would like to express their gratitude to the Radiology Department at Ain Shams University for providing the facilities and support required to carry out this study. Special thanks to all the patients who agreed to participate and the technical staff involved in MRI acquisition and analysis.

Major statement

The prevalence of adnexal masses leads to a substantial clinical burden in the areas of pathology, surgery, and diagnostic imaging. Ovarian-Adnexal-Reporting-and-Data System "O-RADS™" MRI, is an acronym for an O-RADS™. It will serve as a quality assurance tool for risk stratification classification of adnexal lesions, improving communication between the referring and interpreting staff with a dependable method to distinguish between a benign and a malignant adnexal mass.

Hlavní stanovisko práce

Ovarian-Adnexal-Reporting-and-Data System „O-RADS™" MR slouží jako nástroj pro zajištění kvality při klasifikaci stratifikací rizika adnexálních lézí a zlepšuje komunikaci mezi indikujícím a interpretujícím lékařem pomocí spolehlivé metody odlišující mezi benigní a maligní povahou ložiska adnex.

SUMMARY

Mohsen Gomaa Hassan Ismail, Rasha Salah-Eldin Hussien, Basant Mohamed Raief Mosaad, Arwa Adel Mahmoud Hendy. O-RADS MRI score for assessment of adnexal masses

Objective: Validate the O-RADS MRI in risk stratification of adnexal masses and to assess applicability of its use in daily practice regardless the experience of the reader.

Methods: Our study carried out from November 2021 to May 2023, Fifty female patients with adnexal masses, aged 17 to 70 years (mean ± SD of 32.94 ± 6.26), underwent pelvic ultrasound followed by pelvic MRI with dynamic contrast enhancement.

Results: The addition of DWI to the conventional MRI increased the sensitivity, accuracy, it was also useful in the characterization of ovarian masses with sensitivity and specificity over 90%. We assessed each ovarian lesion qualitatively regarding the type of curve and then we measured the semi-quantitative parameters for each lesion by differentiation between Benign vs. Malignant with the sensitivity was 100%, specificity 100%, PPV 100% and NPV was 100% and accuracy 100%, there was a excellent accuracy and between the borderline vs. Malignant with the sensitivity was 80%, specificity 100%, PPV 100% and NPV was 81.8% and accuracy 89.5% that was a good accuracy.

Conclusion: DCE is useful in the characterization of ovarian masses. Assessing

SOUHRN

Mohsen Gomaa Hassan Ismail, Rasha Salah-Eldin Hussien, Basant Mohamed Raief Mosaad, Arwa Adel Mahmoud Hendy. O-RADS MR skóre v hodnocení adnexálních nádorů

Cíl: Ověřit O-RADS MR při stratifikaci rizika adnexálních ložisek a posoudit použitelnost v každodenní praxi bez ohledu na zkušenosti hodnotitele.

Metodika: Studie byla prováděna od listopadu 2021 do května 2023. Padesát pacientek s adnexálními tumory ve věku od 17 do 70 let (průměr ± SD 32,94 ± 6,26) podstoupilo pánevní ultrazvukové vyšetření následované pánevní MR s dynamickým kontrastním zvýrazněním.

Výsledky: Přidání DWI k konvenční MR zvýšilo citlivost a přesnost a bylo také užitečné při charakterizaci ovariálních mas se senzitivitou a specificitou přes 90 %. Každou ovariální lézi jsme kvalitativně vyhodnotili z hlediska typu křivky a poté jsme hodnotili semikvantitativní parametry pro každou lézi rozlišením mezi benigní a maligní se senzitivitou 100 %, specificitou 100 %, PPV 100 % a NPV 100 % a přesností 100 %. Byla dosažena vynikající přesnost a mezi hraničními a maligními lézemi byla senzitivita 80 %, specificita 100 %, PPV 100 % a NPV 81,8 % a vysoká přesnost 89,5 %.

Závěr: DCE je užitečné při charakterizaci ovariálních mas. Při hodnocení ovariálních lézí z hlediska typu křivky sycení jsou

ovarian lesions regarding the type of curve the semi-quantitative parameters are considered prognostic tools for differentiation between Benign vs. Malignant.

Key words: O-RADS MRI, Adnexal Masses, Ovarian Tumors, Risk Stratification, Dynamic Contrast Enhancement (DCE-MRI).

semikvantitativní parametry považovány za prognostické nástroje vhodné pro rozlišení mezi benigním a maligním.

Klíčová slova: O-RADS MR, adnexální nádory, ovariální tumory, stratifikace rizika, dynamické kontrastní sycení (DCE-MR).

INTRODUCTION

Ultrasound (US) remains the primary imaging modality for adnexal masses, while magnetic resonance imaging (MRI) is typically reserved for problem-solving scenarios. The O-RADS™ (Ovarian-Adnexal Reporting and Data System) was introduced as a quality assurance tool for standardized risk stratification of adnexal lesions, improving communication between referring and interpreting physicians (1).

Even after applying the International Ovarian Tumor Analysis (IOTA) Simple Rules or other ultrasound-based scoring systems, some adnexal masses remain indeterminate. Ovarian cancer, a lethal disease, often prompts surgical intervention for sonographically ambiguous masses, many of which are benign. This can result in unnecessary or overly extensive surgeries, leading to morbidity and potential infertility (2).

To address this, the American College of Radiology (ACR) developed **O-RADS US**, integrating statistical modeling from the IOTA group to classify lesions into six risk categories (0–5) according to malignancy prevalence. Still, approximately 25% of masses remain indeterminate post-US assessment, with studies reporting variable – and sometimes low – positive predictive values for ovarian cancer detection. MRI can help reduce false positives in such cases, preventing unnecessary surgery for benign lesions (3).

Given these limitations, a validated scoring system for preoperative risk assessment is needed to standardize reporting and guide surgical decision-making. MRI, with its superior spatial resolution and tissue contrast, is well suited for characterizing adnexal lesions. The ACR O-RADS MRI Committee has developed a risk classification framework and standardized terminology to improve diagnostic consistency. This MRI-based score categorizes lesions into five groups based on the likelihood of malignancy, showing high predictive accuracy for differentiating benign from malignant lesions in cases ambiguous on US (4).

Additionally, dynamic contrast-enhanced MRI (DCE-MRI) can noninvasively evaluate microcirculatory perfusion and vascular permeability, offering more detailed lesion characterization through time-intensity curves (TIC) and semi-quantitative analysis (5). This study aims to validate O-RADS MRI for risk stratification of adnexal masses and assess its clinical applicability regardless of reader experience.

Methods

Patients

Fifty individuals, age ranged from 17 to 70 years with mean ± SD of 32.94 ± 6.26, with adnexal lesions participated in this prospective trial. After being transferred from the gynecological department to the radiology department, each patient underwent a multiparametric MRI.

Inclusion criteria

Women patients who are diagnosed with adnexal masses (suspicious/ indeterminate) detected by US or benign adnexal masses that need better characterization by MRI (All symptomatic or accidentally discovered patients with large cystic, cystic lesion with solid components, complex ovarian lesions, thick septa or soft tissue component; adnexal lesions) No age predilection.

Exclusion criteria

Those who experience claustrophobia and recognized contraindications for MRI examination, such as those with aneurysm clips or pacemakers.

Clinical Assessment

Every patient had a complete medical history taken, with particular attention to age, parity, menopause, previous gynecological issues or surgeries, a positive family history of gynecological cancer, and standard laboratory testing.

Study Procedure

Patient Preparation

- Detailed explanation of the procedure.
- Obtaining an informed signed consent by the patient or one of her guardians.
- Fasting for 6 hours and serum creatinine.

Prior to the assessment, cases were told to fast for four hours and void their urine two hours beforehand. To lessen intestinal peristalsis, 10 mg of an antispasmodic medication was administered intravenously right before MR imaging.

Methods

MRI Equipment

Machine: Patients underwent MR examination using a High field machine (Philips medical system 1.5 T or 3 T, Netherlands).

MRI sequences

- Sagittal T2WI without fat suppression
- Axial T2WI without fat sat
- Axial T2WI in and out of phase
- Axial diffusion weighted images
- DCE MRI 3D T1WI without fat sat

Image analysis

MR images were analyzed for the following:

DWI Interpretation

Qualitative analysis
Regarding the signal intensity, T2WI served as the foundation reference for mass detection in our data analysis. On various b values (0, 500, 1000, and 1500), DW pictures were examined for the presence of persistently high SI (limited diffusion) in respect to the solid components of the included masses. To accurately locate the solid tissue of the masses under investigation, T2- and DW images were fused using a Phillips Advantage Windows workstation equipped with functional tool software.

Accordingly, the anatomical data supplied by the morphologic T2-weighted sequences might be integrated with the distinct functional information of DW-MRI.

Interpretation of Dynamic contrast-enhanced MRI

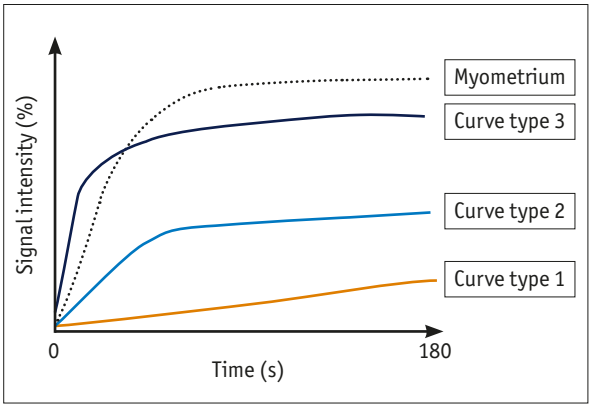
To identify the augmentation of the solid component, the tumor wall, and the septations, post-contrast pictures were utilized. Regions of interest (ROI) were chosen based on the solid component's most boosting region. The computer program automatically computed the data and matched it to temporal intensity curves. For correct ROI placement, the typical procedure was the postcontrast subtracted sequence. The enlarged viable tumor tissue was more localized in the subtraction pictures, and it was clearly visible against a backdrop of signal suppression from the surrounding fat, bowel, and ± ascites.

There are three types of curves.

Type 1 – when, in contrast to the myometrium, solid tissue is augmented with a weak and progressive curvature.

Type 2 – When there is a moderate increase in solid tissue compared to a plateau in the myometrium.

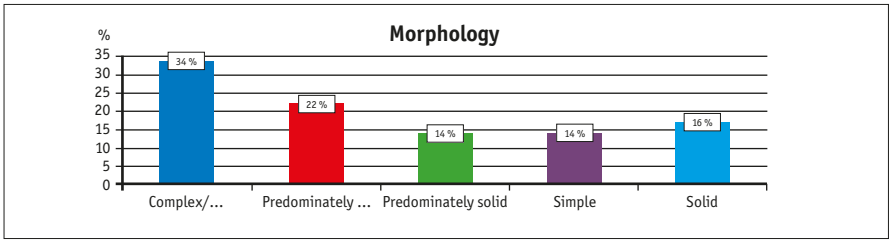
Type 3 – regardless of the degree of augmentation, when solid tissue has a curve steeper than the myometrium's.



The Time-Intensity Curve (TIC) illustrates three characteristic enhancement patterns observed in dynamic contrast-enhanced MRI (DCE-MRI) of adnexal lesions. **Curve Type 1** shows a gradual and continuous rise in signal intensity, typically associated with benign lesions. **Curve Type 2** demonstrates a moderate initial rise followed by a plateau, which is commonly seen in borderline tumors. **Curve Type 3** displays a steep early rise in enhancement followed by a washout phase, a pattern highly suggestive of malignancy. The myometrium is represented by a dotted reference line, serving as a baseline for comparing lesion vascularity

Statistical analysis

Version 23.0 of the statistical program for social sciences was employed. In the case of parametric distribution, the quantitative data were displayed as mean± standard deviation and ranges, whereas non-parametric variables were displayed as median with inter-quartile range. Following that, appropriate statistical analyses were used. The results' significance was assessed at the 0.05 level.



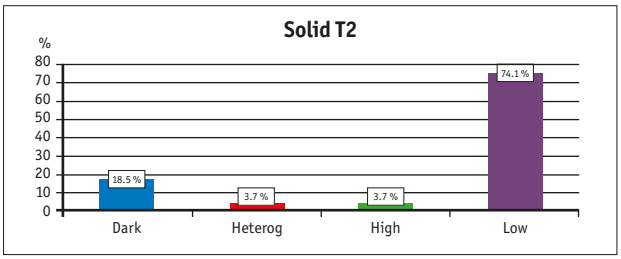
Graph 1. **Relation between adnexal lesions morphology and pathology**
Graf 1. **Vztah mezi morfologií adnexálních lézí a patologií**

Table 1. **Age Group distribution among study group***

Tab. 1. **Věková struktura celkové studované populace***

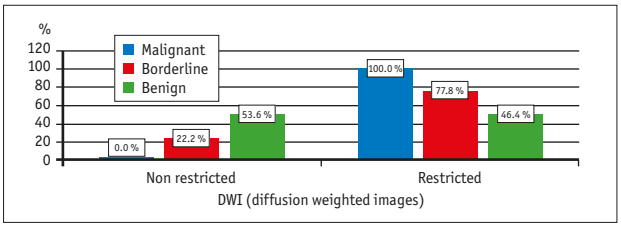
Age Group	No.	%
≤ 30 years	37	74.0%
> 30 years	13	26.0%
Total	50	100.0%*

Table 1 described the age distribution of the total study population. Age ranged from 17 to 70 years with mean ± SD of 32.94 ± 6.26. There were 37 patients (74%) who were "≤ 30 years" and 13 patients (26%) were " > 30 years"
*Věk se pohyboval od 17 do 70 let s průměrem ± SD 32,94 ± 6,26. Bylo zde 37 pacientek (74 %), které byly „≤ 30 let", a 13 pacientek (26 %), které byly „> 30 let".



Graph 2. **Relation between outcome results for pathology according to solid T2**

Graf 2. **Vztah mezi výsledky patologie podle solidního T2**



Graph 3. **Relation between Outcome results for pathology according to DWI (diffusion weighted images)**

Graf 3. **Vztah mezi výsledky patologie podle DWI (difuzně vážené obrazy)**

RESULTS

Our study we applied our study on 50 patients, with the same inclusion and exclusion criteria (Graph 1).

This chart shows relation between the morphology of adnexal lesions a pathology that presents most cases were complex/ multilocular, with 17 cases (34%), followed by predominately cystic/ cystic with papillae, with 11 cases (22%); then the predominately solid 7 patients (14%), 7 patients (14%) were simple and 8 patients (16%) were solid.

There was a highly statistically significant association between outcome results for pathology according to morphology, with p-value ($p < 0.001$). As well as increase predominantely solid in malignant group (Graph 2).

There was a highly statistically significant association between outcome results for pathology according to solid T2, with p-value ($p < 0.001$). As well as increase low of solid T2 in malignant group, followed by borderline and then the benign group.

Table 2. **Relation between Outcome results for pathology according to DWI (diffusion weighted images)***

Tab. 2. **Vztah mezi výsledky patologie podle DWI (difuzně vážené obrazy)***

DWI (diffusion weighted images)	Outcome results for pathology						χ2	p-value
	Malignant		Borderline		Benign			
	No.	%	No.	%	No.	%		
Non restricted	0	0.0%	2	22.2%	15	53.6%	12.320	0.015*
Restricted	10	100.0%	7	77.8%	13	46.4%		
Total	10	100.0%	9	100.0%	28	100.0%		

*Table 2 showed that there was a statistically significant association between outcome results for pathology according to DWI (diffusion weighted images), with p-value ($p < 0.05$). As well as increase restricted in malignant group, followed by borderline and then the benign group.
*Ukázalo se, že existuje statisticky významná souvislost mezi výsledky patologie podle DWI (difuzně vážené obrazy) s hodnotou p ($p < 0,05$). Stejně jako nárůst omezený v maligní skupině, následovaný hraniční a benigní skupinou.

Table 3. **Relation between Outcome results for pathology according to Delayed post contrast***

Tab. 3. **Vztah mezi výsledky patologického vyšetření podle zpožděného kontrastního zobrazení***

Delayed post contrast	Outcome results for pathology						χ2	p-value
	Malignant		Borderline		Benign			
	No.	%	No.	%	No.	%		
No	0	0.0%	6	85.7%	10	100.0%	22.379	0.001**
Yes	9	100.0%	1	14.3%	0	0.0%		
Total	9	100.0%	7	100.0%	10	100.0%		

*Table 3 showed that there was a statistically significant association between outcome results for pathology according to delayed post contrast, with p-value ($p < 0.001$). As well as increase delayed post contrast in malignant group, followed by borderline and then the benign group.
*Ukázalo se, že existuje statisticky významná souvislost mezi výsledky patologického vyšetření podle zpožděného kontrastního zobrazení, s hodnotou p ($p < 0,001$). Stejně jako zvýšení zpožděného kontrastního zobrazení v maligní skupině, následované hraniční a benigní skupinou.

CASE PRESENTATION

Case 1

Clinical presentation

A 22-year-old woman arrived with distension in her abdomen and pelvic discomfort. CA-125 was not raised, but the US showed a massive midline complicated adnexal lesion with a mostly cystic component and many septae that exhibit vascularity in the Doppler investigation (Fig. 1).

Conventional MRI: **(a–e)** A massive, primarily cystic adnexal lesion is visible

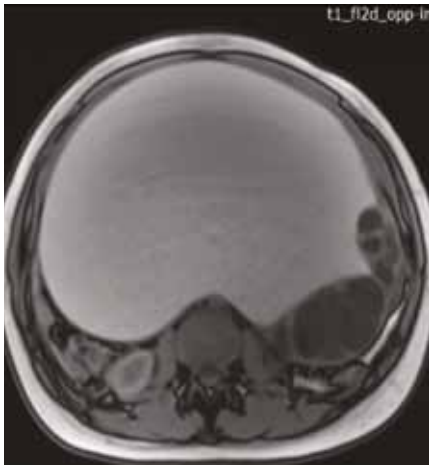
Table 4. **Relation between Outcome results for pathology according to O-RADS***

Tab. 4. **Vztah mezi výsledky patologie podle O-RADS***

O-RADS	Outcome results for pathology						χ2	p-value
	Malignant		Borderline		Benign			
	No.	%	No.	%	No.	%		
Grade 2	0	0.0%	1	11.1%	20	64.5%	65.208	0.001**
Grade 3	0	0.0%	2	22.2%	11	35.5%		
Grade 4	2	20.0%	6	66.7%	0	0.0%		
Grade 5	8	80.0%	0	0.0%	0	0.0%		
Total	10	100.0%	9	100.0%	31	100.0%		

*Table (4) showed that there was a highly statistically significant association between outcome results for pathology according to O-RADS, with p-value ($p < 0.001$). As well as increase grade 4 and Grade 5 in malignant group, followed by borderline and then the benign group.
*Ukázalo se, že existuje vysoce statisticky významná souvislost mezi výsledky patologie podle O-RADS s hodnotou p ($p < 0,001$). Stejně jako nárůst stupně 4 a stupně 5 v maligní skupině, následovaný hraniční a benigní skupinou.

1a



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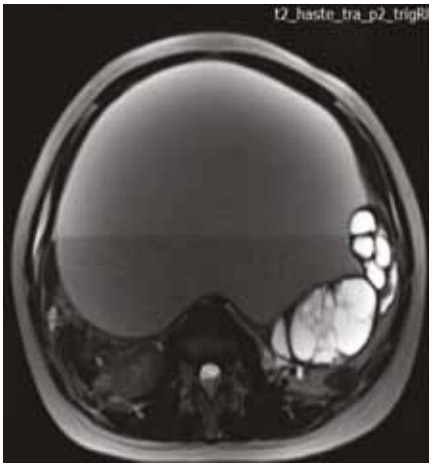

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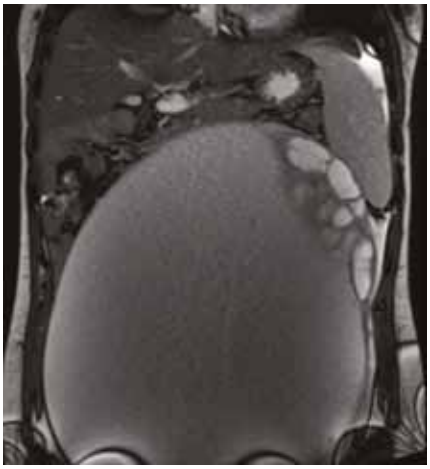

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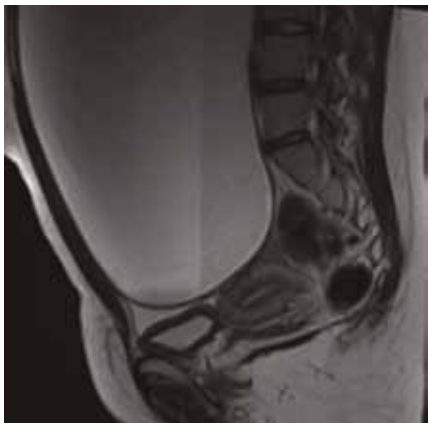

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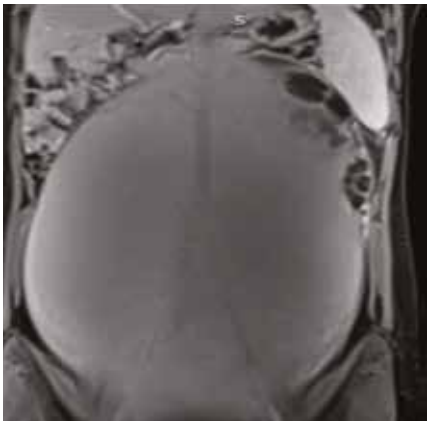

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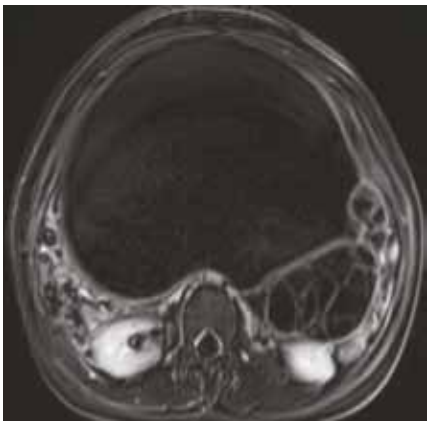

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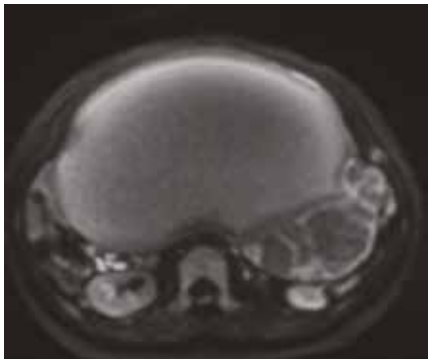

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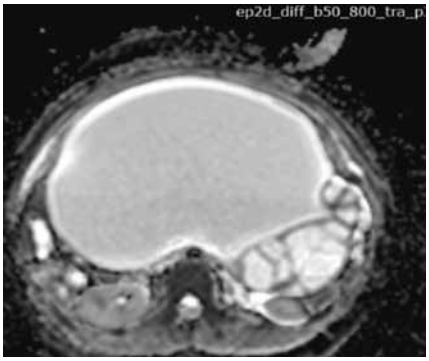

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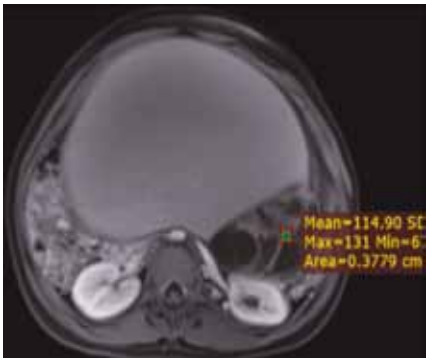

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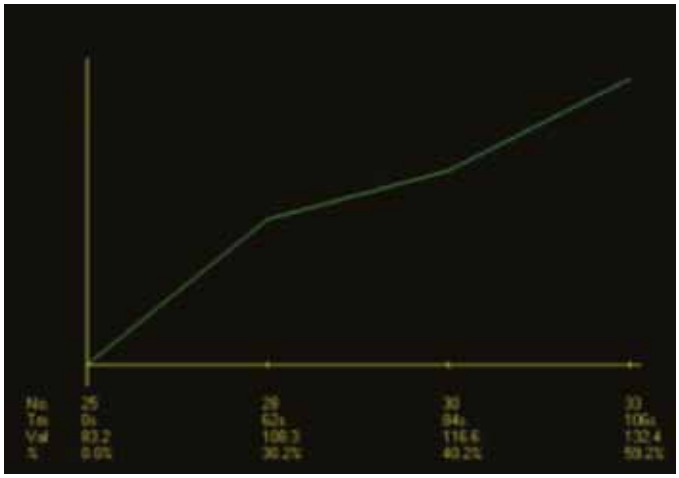
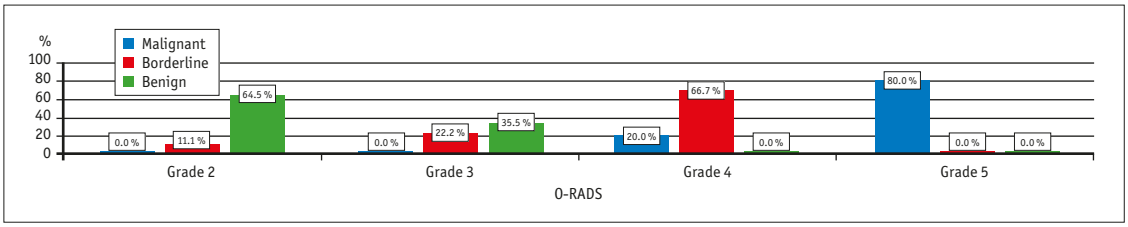


1 Multiparametric MRI of a 22-year-old female with a large complex adnexal lesion – conventional MRI: (a) axial T1; (b) axial T2; (c) coronal T2; (d) sagittal T2; (e) coronal T1; (f) T1 post-contrast subtraction; (g) DWI – diffusion weighted image; (h) ADC – apparent diffusion coefficient; (i) DCE – dynamic contrast enhanced; (j) TIC – time intensity contrast curve

Multiparametrická MR 22leté ženy s rozsáhlou komplexní adnexální lézí – konvenční MR: (a) axiální obraz T1; (b) axiální obraz T2; (c) koronární obraz T2; (d) sagitální obraz T2; (e) koronární obraz T1; (f) T1 postkontrastní odčítání; (g) DWI – difuzně vážený obraz; (h) ADC – aparentní difuzní koeficient; (i) DCE – dynamický postkontrastní obraz; (j) TIC – křivka vývoje intenzity sycení



Graph 4. **Diagnostic accuracy between O-RADS MRI score and histopathology (as a reference) in assessment of adnexal masses**

Graf 4. **Diagnostická přesnost mezi skóre O-RADS MR a histopatologií (jako referencí) při hodnocení adnexálních mas**

Table 5. **Diagnostic accuracy between O-RADS MRI score and histopathology (as a reference) in assessment of adnexal masses***

Tab. 5. **Diagnostická přesnost mezi skóre O-RADS MRI a histopatologií (jako referencí) při hodnocení adnexálních mas***

O-RADS MRI score	Sen.%	Spe.%	PPV%	NPV%	Accuracy %
Borderline vs. Malignant					
Grade 2,3,4 vs. Grade 5	80.0%	100.0%	100.0%	81.8%	89.5%
Benign vs. Malignant					
Grade 2,3 vs. Grade 4	100.0%	100.0%	100.0%	100.0%	100.0%

*Table 5 showed that the diagnostic and discriminatory ability to evaluate overall finding results is evident from the O-RADS compared to pathology as a reference and it is also demonstrated that the more O-RADS achieves the detection and evaluation of adnexal masses.
*Ukázalo se, že diagnostická a diskriminační schopnost vyhodnotit celkové výsledky nálezů je zřejmá z O-RADS ve srovnání s patologií jako referencí a také se prokázalo, že čím více O-RADS dosahuje detekce a hodnocení adnexálních mas.

Benign vs. Malignant: Grade 2, 3 vs. Grade 4: The sensitivity was 100%, specificity 100%, PPV 100% and NPV was 100% and accuracy 100%, there was a excellent accuracy
Borderline vs. Malignant: Grade 2, 3, 4 vs. Grade 5: The sensitivity was 80%, specificity 100%, PPV 100% and NPV% was 81.8% and accuracy 89.5%, there was a good accuracy.

on axial T2, axial T1, sagittal, and coronal T2 weighted images. The lesion measures 30 cm and produces mixed (intermediate) and mixed (hyperintense) T2 and septal components, which exhibit septal enhancement in the post contrast series **(f)**. There was also a very little pelvic fluid visible.

Findings are suggestive of a Mucinous neoplasm of ovary **(e & f) Diffusion WI and ADC map:** demonstrates mild diffusion restriction of the septate with estimated mean **ADC value measures** 2525 for cystic component and for 1257 for septae. **(i & h) DCE with TIC curve** shows type II curve: initial rapid rise with plateau MRE%: 117.5%, T_{max}: 146.6 sec, WIR: 10.2.

Multiparametric MRI diagnosis: Findings are suggestive of left indeterminate ovarian lesion. ORADS 4.

Operative details: Left salpingo-opherctomy and the case was for immunotyping and no follow up.

Final pathological diagnosis
Mucinous neoplasm invading ovary, intact ovarian capsule.

Case 2

Clinical presentation
A 56-year-old female reported with pelvic discomfort and abdominal distention. The US indicated a midline complicated adnexal lesion with cystic gaps and a solid component. CA-125 levels were high.

*MRI findings
Well defined midline adnexal lesion with mixed solid and cystic component and irregular soft tissue component cystic spaces.

Figure 2 **(a–d)** Conventional MRI: axial T2 and axial T1 weighted images show well defined complex left right adnexal lesion, it measures 11 × 5.8 cm that elicits low T1 (that shows multiple internal bright areas and high T2 signals (white arrow? areas of hemorrhage). Coronal T1 post contrast: the lesion shows several internal cystic regions of breakdown and a strong heterogeneous amplification of the solid soft tissue component.

The results point to a malignant ovarian tumor. There is mild ascites.

(e & f) Diffusion WI and ADC map: The limited solid component has an estimated ADC value of 1256, indicating significant diffusion restriction.

(g & h) DCE with color mapping shows type III curve: initial rapid rise with early washout. MRE%: 87.6%, T_{max}: 100.7 sec, WIR: 14.7.

Multiparametric MRI diagnosis: The results support a malignant ovarian tumor on the left. ORADS 5.

Operative details: Patient was treated by total hysterectomy and bilateral salpingo-oophorectomy.

Final pathological diagnosis
Ovarian mass, ovarian Endometrioid carcinoma, on top of endometriotic cyst.

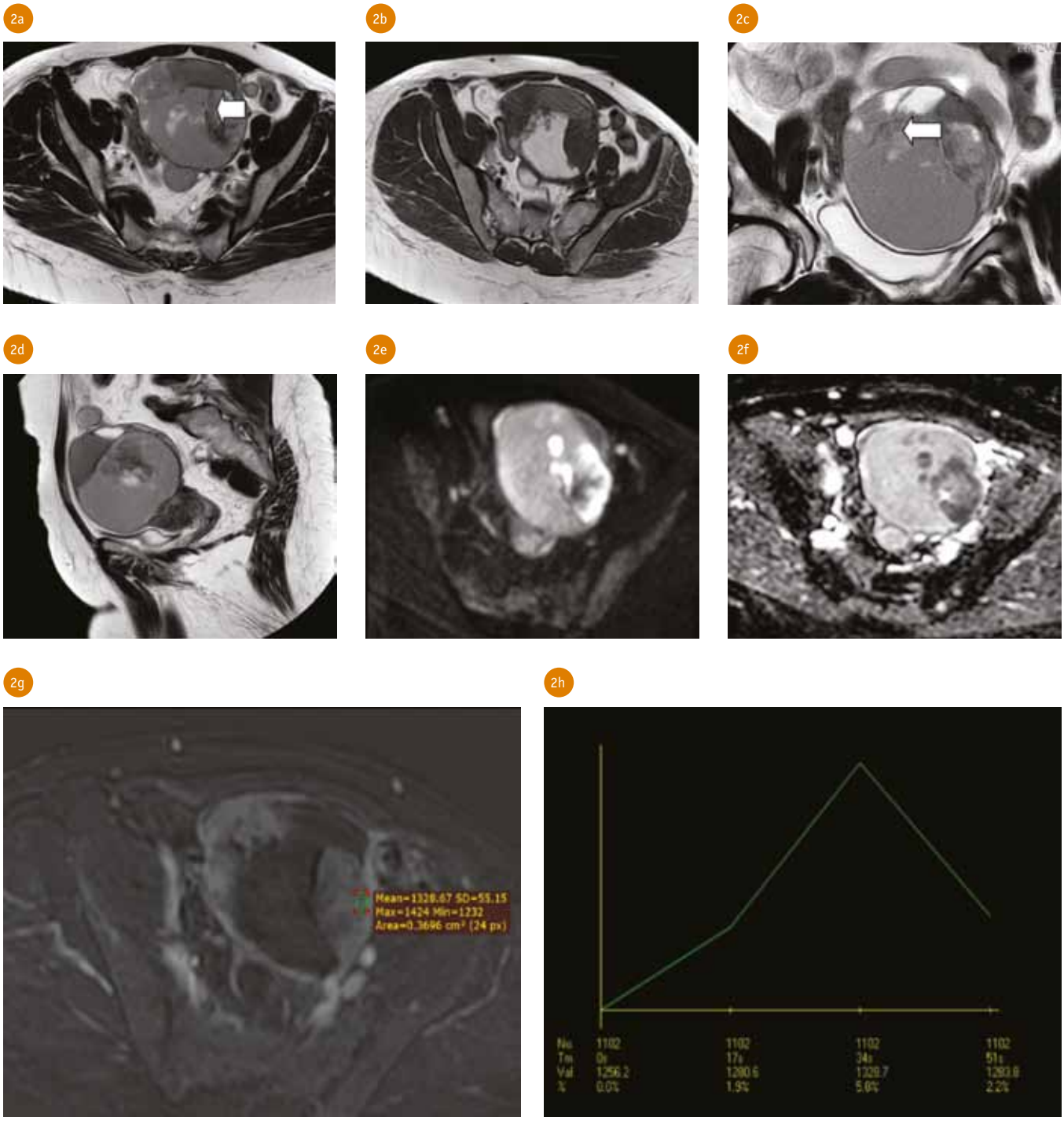
DISCUSSION

In clinical practice, ovarian masses are frequently seen, either incidentally or in patients who are exhibiting symptoms. Characterizing an ovarian lesion is a diagnostic challenge that can affect patient care and is crucial in the preoperative setting to plan appropriate treatment procedures (7).

Proper therapy is dependent on a thorough preoperative assessment, which includes clinical examinations, laboratory testing, and several imaging modalities. This aids in educating the patient about the feasibility of conservative treatment and the surgical course (2).

Aslan et al. (3) examined 332 women who had MRI to better characterize an ambiguous adnexal lesion on US. Using this shortened 5-phase dynamic technique, one experienced radiologist assigned the O-RADS MRI score to each patient. The necessity to deploy a thorough DCE procedure is still being contested among the radiologist community (3).

For the purpose of using MRI to diagnose adnexal lesions, the ACR Ovarian-Adnexal Reporting and Data Systems (O-RADS) MRI Committee created and presented an evidence-based lexicon and risk rating system in 2021. The O-RADS MRI grading approach evaluates the adnexal lesion's MRI appearance and provides a numerical risk score ranging from 1 to 5, with 0 representing inadequate or challenging-to-interpret imaging. According to this approach, the chance of malignancy increases



2 **Conventional MRI:** (a) axial T1; (b) axial T2; (c) coronal T2; (d) sagittal T2; (e) DWI – diffusion weighted; (f) ADC – apparent diffusion coefficient map; (g) DCE – dynamic contrast enhanced; (h) TIC – time intensity contrast curve

Konvenční MR: (a) axiální obraz T1; (b) axiální obraz T2; (c) koronární obraz T2; (d) sagitální obraz T2; (e) DWI – difuzně vážený obraz; (f) ADC – aparentní difuzní koeficient; (g) DCE – dynamický postkontrastní obraz; (h) TIC – křivka vývoje intenzity sycení

with a higher risk score. The O-RADS MRI classification system, like the popular ACR Breast Imaging Reporting and Data System classification, has the clear benefit of using a descriptive and standard language that can facilitate communication between radiologists and referring doctors (5).

In this work, we conducted a separate investigation of the diagnostic performance of DWI, DCE-MR imaging, and pre-contrast MR sequences in assessing complicated adnexal masses.

A meta-analysis that included 4520 adnexal lesions recently validated this, demonstrating that O-RADS MRI has a sensitivity and specificity of above 90% in describing adnexal lesions (7).

Thomassin-Naggara et al. (8) however, identified a number of typical mistakes in O-RADS MRI evaluation and examined the cause of the incorrectly categorized patients in a recent EURAD research. 139 (9.2%) of the 1502 lesions in total were incorrectly categorized (8).

The primary reasons of misclassification were errors in identifying the origin of the lesion (n = 35) and misinterpretation of solid tissue (n = 104). The authors emphasized the importance of radiologist training in

O-RADS MRI, which is comparable to the training offered by the IOTA group. To clarify the phrases „solid tissue“ and „solid component“, which were previously used interchangeably and led to errors in the EURAD research, which led to the inaccurate classification of 63 out of 139 adnexal lesions (9, 10).

In MRI evaluation, “DWI” lesions are crucial. To describe fibrous lesions with uniformly low signal intensity on both T2-weighted and high-b-value DWI MRI scans, the ACR O-RADS MRI committee coined the term „dark T2/dark DWI.“.

We found that there was a strong statistical correlation between the pathological outcome findings and solid T2 (p-value $p < 0.001$), and that the malignant group had the lowest solid T2 levels, followed by the borderline and benign groups.

That match with the study done by Nougaret stated that adnexal lesions having solid tissue and presenting distinctive homogeneous black T2/dark DWI signal intensity on MRI are classed as O-RADS MRI 2 score, regardless of their enhancing features. These lesions are benign, often indicating either fibroma, fibrothecoma, Brenner tumor, or cystadenofibroma (5).

Research is still being conducted to find out how ADC quantification can improve O-RADS MRI score 4, as restricted diffusion is characterized by low signal intensity on the ADC map and high signal intensity on the high-b-value DWI. However, because benign and malignant lesions overlap significantly, this characteristic fails to offer effective risk stratification for adnexal lesions (11).

In our study, there was a statistically significant association between outcome results for pathology according to DWI (diffusion weighted images), with p-value ($p < 0.05$). As well as increase restricted in malignant group, followed by borderline and then the benign group.

We concluded that there was a highly statistically significant highest mean value of ADC value in border line group, followed by benign group and the lowest value in malignant group, with p-value ($p < 0.05$).

According to a report submitted by Basha, adnexal masses were reclassified utilizing the new combined O-RADS MRI/ADC mean technique. Histopathological evidence indicates that DWI increased the number of adnexal masses in category 5 (from 30 to 52) and decreased the number in category 4 (from 62 to 39). For O-RADS 4 and O-RADS 5, we were able to optimize the prevalence of malignancy from 34 to 23 percent and 17 to 30 percent, respectively. However, in category 3, the prevalence of malignancy decreased from 2% to 0%. The literature claims that previous research have shown a significant relationship between the mean ADC value and histotype. Additionally, a higher ADC value is associated with reduced tumor cellularity, while a lower ADC value is associated with higher tumor cellularity (8, 12).

A 2015 research by Mansour et al. found that DWI is not a good method for differentiating between benign and malignant ovarian cancers. Given (i) the inclusion of the conventional MRI data, (ii) the combined analysis of DWI quantitative and qualitative criteria, and (iii) knowledge of the sequence hazards, DWI can confirm or rule out potential malignancy in suspected ovarian tumors. Sensitivity, specificity, PPV, NPV, and accuracy were 93.3%, 85%, 88.5%, 94.4%, and 82.3%, respectively, when DWI was added to conventional MR imaging. This is in contrast to 93.3%, 100%, 100%, 92.3%, and 95% when DCE-MRI was added to the conventional MR (4).

According to a 2020 study by Thomassin-Naggara and associates, the DCE approach is advised for the best assessment of enhanced features in adnexal lesions. This study found, using a 3-D T1WI, that benign ovarian tumors exhibited a gradual increase in enhancement without a distinct peak, malignant lesions exhibit greater enhancement than benign lesions during the early phase of enhancement rather than the late phase of enhancement, and borderline ovarian tumors exhibit moderate initial enhancement followed by a plateau (2).

Curve type 3 seems to be unique for invasive cancers, according to a different research conducted in 2022 by Sadowski EA and associates. Curve type 1 was more common in benign tumors than in malignant ones. There was no difference in the frequency of curve type 2 amongst the three groups (malignant, borderline, and benign). However, because the curve types of the benign and borderline lesions overlapped, they were unable to differentiate between benign and borderline tumors (13, 14).

In our work, 74% of cases (37 cases) show dynamic contrast enhancement while 26% of cases (13 case) show no on enhancement. 14 cases (37.8%) showed (type 1 curve) while the other ten lesions (58.8 %) showed (type 2 curve), while some of the invasive malignant cases 15 (40.5 %) showed (type 3 curve).

However, some borderline tumors (borderline serous cystadenomas) had type 1 curves, whereas some malignant tumors (dysgerminoma, grade I mucinous cystadenocarcinomas, 2 granulosa cell tumor, and moderately differentiated serous cystadenocarcinoma) had type 2 curves, indicating a substantial overlap between benign and borderline lesions. Because the curve patterns overlapped according to the histology type, we integrated the semi-quantitative characteristics (14).

In our study, there was a statistically significant association between outcome results for pathology according to TIC (time intensity curve), with p-value ($p < 0.001$). As well as increase curve 3 in malignant group, followed by borderline and then the benign group, also was a highly statistically significant association between outcome results for pathology according to O-RADS, with p-value ($p < 0.001$). As well as increase grade 4 and Grade 5 in malignant group, followed by borderline and then the benign group.

In a study of 150 complicated or solely solid ovarian masses (42 benign and 108 malignant {26 borderline and 82 invasive malignant}), Mansour and colleagues found that the MRE% was greater for malignant masses than for benign and borderline masses ($p < 0.001$). The efficacy of dynamic post-contrast sequencing to identify ovarian tumors with ambiguous MR characteristics of malignancy was evaluated in this study (4).

Despite having a high specificity for identifying invasive lesions, DCE-MRI methods can have drawbacks. Poorly vascularized malignant tumors can produce false-negative results, while benign lesions with a high blood supply, like tubo-ovarian abscesses, can produce false-positive enhancement characteristics. These lesions can appear complex and indeterminate on all imaging modalities (15).

In our study, the diagnostic and discriminatory ability of the O-RADS MRI

scoring system, using histopathology as the reference standard, was clearly demonstrated. The findings confirm that O-RADS MRI is highly effective in detecting and evaluating adnexal masses. For the differentiation between borderline and malignant lesions (Grades 2, 3, and 4 vs. Grade 5), the sensitivity was 80%, specificity 100%, positive predictive value (PPV) 100%, negative predictive value (NPV) 81.8%, and overall accuracy 89.5%, indicating good diagnostic performance. In distinguishing benign from malignant lesions (Grades 2 and 3 vs. Grade 4), the sensitivity, specificity, PPV, and NPV all reached 100%, with an overall accuracy of 100%, reflecting excellent diagnostic capability.

The advancement of artificial intelligence has the potential to enhance O-RADS MRI performance, much as the BI-RADS classification. In order to help radiologists with BI-RADS classification, a deep neural network (DNN)-based model was recently presented as an effective and dependable tool. It showed an average sensitivity of 95.31% and an overall accuracy of 94.22% in accurately assigning BIRADS scores.

Clinical Implications

This study highlights the clinical value of the O-RADS MRI scoring system combined with dynamic contrast-enhanced MRI and diffusion-weighted imaging as a standardized, accurate, and reproducible approach for evaluating adnexal masses. The method's high diagnostic performance supports its role in reducing unnecessary surgical interventions for benign lesions, while enabling the early detection of malignant tumors and facilitating appropriate surgical planning. By offering a common language between radiologists and clinicians, O-RADS MRI enhances multidisciplinary communication and improves the quality of patient counseling and management strategies.

Strength Points

A major strength of this work lies in its prospective design, with histopathology used as the gold standard for diagnosis. The study integrates both qualitative and semi-quantitative MRI parameters, combining time-intensity curve analysis with diffusion-weighted imaging findings to optimize diagnostic accuracy. The excellent diagnostic performance, including 100% sensitivity and specificity in differentiating benign from malignant lesions, underscores the reliability of the proposed protocol. Additionally, the application of standardized O-RADS MRI terminology enhances reproducibility and supports routine clinical use. The inclusion of a wide age range of participants reflects real-world clinical practice, increasing the clinical relevance of the findings.

Limitations

This study has some limitations. Being a single-center study may limit the generalizability of the results. The relatively small sample size, particularly for the borderline tumor subgroup, may have influenced the statistical power of certain analyses. Interpretation was conducted with knowledge of clinical and ultrasound data, which may have introduced reader bias. Furthermore, interobserver variability in applying the O-RADS MRI scoring system was not formally assessed. Finally, some overlap in time-intensity curve patterns between borderline and benign lesions may reduce diagnostic specificity in selected cases.

CONCLUSION

The DCE is particularly helpful in characterizing ovarian masses since it can accurately distinguish between benign and malignant lesions by evaluating the semi-quantitative parameters for each lesion and the qualitative kind of curve. The O-RADS MRI risk score allows radiologists and referring doctors to communicate more effectively, standardize terminology, and assign the possibility of malignancy to adnexal lesions according to MRI findings in a step-by-step manner. ●

Abbreviation

O-RADS	Ovarian-Adnexal Reporting and Data System
MRI	Magnetic Resonance Imaging
DWI	Diffusion Weighted Imaging
TIC	Time Intensity Curve
ADC	Apparent Diffusion Coefficient
DCE	Dynamic Contrast Enhancement
ROI	Region of Interest
US	Ultrasound
ACR	American College of Radiology
IOTA	International Ovarian Tumor Analysis
NPV	Negative Predictive Value
PPV	Positive Predictive Value

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