Modified O-RADS Ultrasound Classification Using Qualitative Contrast-Enhanced Ultrasound Score for Borderline and Malignant Adnexal Lesions: An External Testing Study

Qingzi Chen, MS, Ju Huang, MS, Zhe Chen, MS, Qiulin Wu, MS, Liangli Hong, MS, Shigao Chen, PhD, Shaoqi Chen, MD, PhD

https://doi.org/10.2214/AJR.25.34326
Accepted: January 28, 2026
Article Type: Research Letter
Article Section: Genitourinary Imaging

The complete title page, as provided by the authors, is available at the end of this article.

Recommended citation:
Chen Q, Huang J, Chen Z, et al. Modified O-RADS Ultrasound Classification Using Qualitative Contrast-Enhanced Ultrasound Score for Borderline and Malignant Adnexal Lesions: An External Testing Study. *AJR* 2026 Feb 4 [published online]. Accepted manuscript. doi:10.2214/AJR.25.34326

A supplement to this article is available at:
https://www.ajronline.org/doi/suppl/10.2214/AJR.25.34326/suppl_file/25_34326_suppl.pdf

O-RADS Ultrasound provides a standardized framework for risk stratification of adnexal masses based primarily on morphologic and Doppler features (1). However, borderline ovarian tumors (BOTs) share characteristics features with both benign lesions and malignancies, leading to diagnostic uncertainty and potential overtreatment for O-RADS category 4 and 5 lesions (2,3). Contrast-enhanced ultrasound (CEUS) has demonstrated high accuracy in differentiating benign from malignant ovarian tumors (3). One study showed improved O-RADS Ultrasound performance when potentially modifying the category using a proposed 5-point CEUS score reflecting qualitative assessment of a lesion's enhancement time, enhancement intensity, and dynamic change in enhancement from peak intensity to clearance (4); that study had only internal testing and grouped BOTs with malignancies. The present study performed external testing of the diagnostic performance of the modified O-RADS Ultrasound classification based on the 5-point CEUS score for detection of BOTs and malignant adnexal lesions.

The institutional review board approved this retrospective study, waiving the requirement for written informed consent. The study included 357 consecutive patients (mean age, 48 years) who underwent conventional ultrasound and CEUS before surgical resection of an adnexal mass at the study institution between December 2020 and December 2024. No patients were excluded. Two radiologists (reader 1 [R1, S.Q.C.] and reader 2 [R2, Z.C.], with 19 and 14 years, respectively, of experience in gynecologic ultrasound) independently evaluated the ultrasound examinations. The readers assigned each lesion an O-RADS Ultrasound category based on morphologic and Doppler descriptors and a qualitative CEUS score using the 5-point scale described by Yuan et al. (4). Also as described by Yuan et al., O-RADS category 4 was downgraded to category 3

when the CEUS score was ≤2 and upgraded to category 5 when the score was ≥4. The Supplemental Methods provides additional details.

Interreader agreement was assessed using weighted kappa coefficients. Diagnostic performance of original and modified O-RADS categories, both considered positive when ≥4, for BOT and for malignancy was evaluated using sensitivity, specificity, accuracy, and AUC.

Table S1 summarizes characteristics of patients and lesions. A total of 129 (36%) lesions were benign, 112 (31%) were borderline, and 116 (33%) were malignant. The kappa coefficient for the initial O-RADS category was 0.984, for CEUS score was 0.975), and for modified O-RADS category was 0.971. The median CEUS score for benign, borderline, and malignant lesions was 4.0 (IQR, 4.0-4.0), 3.0 (IQR, 3.0-3.0), and 5.0 (IQR, 4.0-5.0) for R1, and 4.0 (IQR, 4.0-4.0), 3.0 (IQR, 3.0-3.0), and 5.0 (IQR, 4.8-5.0) for R2, respectively.

Table 1 reports diagnostic performance results. Sensitivity, specificity, and accuracy for BOT for R1 using original O-RADS category were 81.3%, 85.3%, and 84.0%; and using modified O-RADS category were 92.0%, 94.7%, and 93.8%; and for BOT for R2 using original O-RADS category were 80.4%, 84.5%, and 83.2%; and using modified O-RADS category were 91.1%, 93.9%, and 93.0%, respectively. Sensitivity, specificity, and accuracy for malignancy for R1 using original O-RADS category were 89.7%, 92.1%, and 91.3%, and using modified O-RADS category were 97.4%, 98.3%, and 98.0%; and for malignancy for R2 using original O-RADS category were 88.8%, 91.3%, and 90.5%; and using modified O-RADS category were 96.6%, 97.9%, and 97.5%, respectively. All metrics were significantly higher ($p<.05$) for modified than original O-RADS for both

readers. Figures 1 and S1 show representative examples of the use of the CEUS score to aid diagnosis.

The qualitative score reflects tumor perfusion behavior and can be applied during routine CEUS examinations without postprocessing or complex modeling. In this study, overall lower CEUS scores were observed in BOTs than in malignant lesions, consistent with prior pathologic and imaging studies reporting lower microvascular density in BOTs than in invasive carcinomas (5,6).

Limitations should be acknowledged. The study was performed retrospectively at one center. Additionally, the cohort included only surgically resected lesions, introducing selection bias. The impact of the CEUS score on clinical decision-making in nonoperative cases was not evaluated. Also, the original and modified O-RADS categories were assessed for the two endpoints (BOT and malignancy) using identical threshold criteria (category ≥4).

In conclusion, in this external testing study, a qualitative 5-point CEUS score improved both the sensitivity and specificity of O-RADS Ultrasound for detection of both BOTs and malignancies. This approach may help avoid overtreatment for benign lesions.

References

1. Andreotti RF, Timmerman D, Strachowski LM, et al. O-RADS US risk stratification and management system: a consensus guideline from the ACR Ovarian-Adnexal Reporting and Data System Committee. *Radiology* 2020; 294:168-185.

2. Wang R, Liu H, Tang J, et al. The application value of two-dimensional ultrasound combined with contrast-enhanced ultrasound in the differential diagnosis of benign, borderline, and malignant ovarian epithelial tumors. *Journal of Ovarian Research* 2024; 17:191.

3. Li J, Kong W-m. Diagnostic value of contrast-enhanced ultrasound in ovarian cancer: a meta-analysis. *Acta Radiologica* 2025; 66:461-469.

4. Yuan K, Huang Y-J, Mao M-Y, et al. Contrast-enhanced US to improve diagnostic performance of O-RADS US risk stratification system for malignancy. *Radiology* 2023; 308:e223003.

5. Shentu W, Zhang Y, Gu J, et al. Contrast-enhanced ultrasonography for differential diagnosis of adnexal masses. *Frontiers in oncology* 2022; 12:968759.

6. Li X, Lu H, Zeng R, et al. Conventional ultrasound and high-frame-rate contrast-enhanced ultrasound characteristics of ovarian thecoma-fibroma groups. *Quant Imaging Med Surg* 2025; 15:3875-3890.

Table 1. Diagnostic performance of initial O-RADS Ultrasound category and modified category based on qualitative CEUS score for outcomes of borderline ovarian tumor and malignancy (N = 357).

Diagnosis, Classification, and Reader	Sensitivity	Specificity	Accuracy	AUC
Borderline ovarian tumor				
Initial O-RADS				
Reader 1	81.3 (74.0-88.5) [91/112]	85.3 (80.9-89.7) [209/245]	84.0 (80.2-87.8) [300/357]	0.893 (0.838–0.947)
Reader 2	80.4 (73.0-87.7) [90/112]	84.5 (80.0-89.0) [207/245]	83.2 (79.3-87.1) [297/357]	0.886 (0.849–0.923)
CEUS-modified O-RADS				
Reader 1	92.0 (87.0-97.0) [103/112]	94.7 (91.9-97.5) [232/245]	93.8 (91.3-96.3) [335/357]	0.969 (0.940–0.998)
p	.03	.001	<.001	.02
Reader 2	91.1 (85.8-96.4) [102/112]	93.9 (90.9-96.9) [230/245]	93.0 (90.4-95.6) [332/357]	0.961 (0.932–0.990)
p	.03	.001	<.001	.002
Malignancy				
Initial O-RADS				
Reader 1	89.7 (84.2-95.2) [104/116]	92.1 (88.7-95.5) [222/241]	91.3 (88.4-94.2) [326/357]	0.921 (0.865–0.978)
Reader 2	88.8 (83.1-94.5) [103/116]	91.3 (87.8-94.8) [220/241]	90.5 (87.5-93.5) [323/357]	0.915 (0.858–0.972)
CEUS-modified O-RADS				
Reader 1	97.4 (94.5-100.0) [113/116]	98.3 (96.7-99.9) [237/241]	98.0 (96.6-99.4) [350/357]	0.993 (0.984–1.000)
p	.03	.002	<.001	.01
Reader 2	96.6 (93.3-99.9) [112/116]	97.9 (96.1-99.7) [236/241]	97.5 (95.9-99.1 [348/357]	0.991 (0.981–1.000)
p	.04	.002	<.001	.01

Note: Sensitivity, specificity, and accuracy reported as percentage with 95% CI in brackets and numerator and denominator in parentheses, based on classification as positive for category ≥3; AUC reported with 95% CI in parentheses. P values are for comparison with initial O-RADS.

CEUS, contrast-enhanced ultrasound

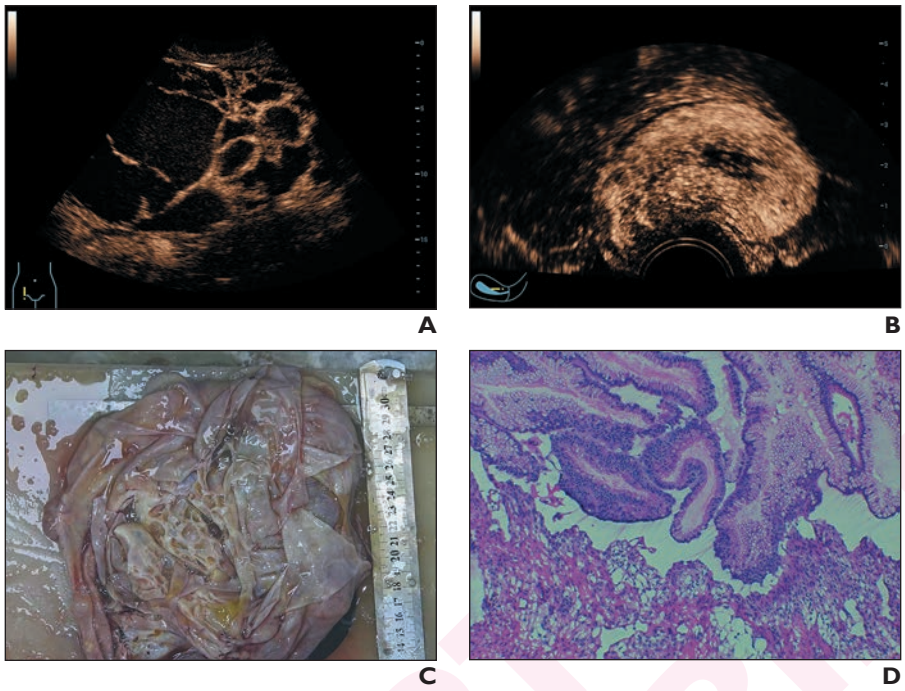

Figure 1. 57-year-old woman with adnexal lesion. (A) Contrast-enhanced ultrasound image shows right adnexal lesion. (B) Contrast-enhanced ultrasound image shows normal myometrium. Lesion shows isoenhancement relative to myometrium. Reader 1 assigned original O-RADS category of 4, qualitative CEUS score of 3, and modified O-RADS category of 4. Reader 2 assigned original O-RADS category of 3, qualitative CEUS score of 4, and modified O-RADS category of 4. (C) Sectioned surgical specimen shows cystic mass with multiple internal septations. (D) Photomicrograph (H&E stain, x100) shows fibrous cyst wall lined by mucinous columnar epithelium with epithelial stratification and mild-to-moderate cytologic atypia and absence of stromal invasion, consistent with mucinous borderline ovarian tumor.

AJR

Research Letter

Modified O-RADS Ultrasound Classification Using Qualitative Contrast-Enhanced Ultrasound Score for Borderline and Malignant Adnexal Lesions: An External Testing Study

Running Title: Qualitative CEUS Score for Adnexal Lesions

Qingzi Chen[1†], MS, Ju Huang[2†], MS, Zhe Chen[3], MS, Qiulin Wu[4], MS, Liangli Hong[5], MS, Shigao Chen[6], PhD, Shaoqi Chen[1*], MD, PhD

[1]Department of Medical Ultrasound, First Affiliated Hospital of Shantou University Medical College, Shantou, Guangdong Province, People's Republic of China.

[2]Department of Gynecology, First Affiliated Hospital of Shantou University Medical College, Shantou, Guangdong Province, People's Republic of China.

[3]Department of Interventional Ultrasound, Cancer Hospital of Shantou University Medical College, Shantou, Guangdong Province, People's Republic of China.

[4]Laboratory of Medical Molecular Imaging, First Affiliated Hospital of Shantou University Medical College, Shantou, Guangdong Province, People's Republic of China.

[5]Department of Pathology, First Affiliated Hospital of Shantou University Medical College, Shantou, Guangdong Province, People's Republic of China.

[6]Department of Radiology, Mayo Clinic, Rochester, Minnesota, USA.

[†]These authors contributed equally to this work.

***Corresponding author:**

Shaoqi Chen

E-mail: chensq@stu.edu.cn

TEL: +86-13790884548

Fax: +86075488259850

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of The First Affiliated Hospital of Shantou University Medical College(B-2024-075). The requirement for written informed consent for this retrospective analysis was waived by the IRB.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Author contributions

Qingzi Chen, Ju Huang and Shaoqi Chen carried out the studies, participated in collecting data, and drafted the manuscript. Qiulin Wu and Shigao Chen performed the statistical analysis and participated in its design. Zhe Chen and Liangli Hong participated in acquisition, analysis, or interpretation of data and draft the manuscript. All authors read and approved of the final manuscript.

Acknowledgements

Not applicable

Conflict of interests

All authors declare that they have no any conflict of interests.

Funding

This study was supported by the Guangdong Provincial Government-Enterprise Joint Fund (grant no. 2024A1515220034), Guangdong Yiyang Healthcare Charity Foundation (grant no.JZ20240787) and 2023 China Ultra sonographers Rising Stars of Science and Technology Research Program. The funding bodies had no role in the design of the study, the collection, analysis, and interpretation of data, and the writing of the manuscript.