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Imaging Considerations for Adnexal Masses

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Background and Clinical Context

Adnexal masses are commonly found during routine imaging of the pelvis and can be seen in up to 4-5% of asymptomatic women undergoing pelvic ultrasound (US).[1] These masses encompass a range of pathologies from both gynecologic and non-gynecologic origins and can either be benign or malignant.

In Canada the lifetime risk for ovarian cancer is 1.7%. There are approximately 3,100 cases per annum in Canada with 2,000 deaths.[2] Despite its low prevalence, ovarian malignancy is a leading cause of death among gynecological malignancies, with a 5-year survival rate of 47%. Imaging plays an integral role in the detection, characterization, and appropriate triage of adnexal masses.

The majority of adnexal masses are benign and can be managed conservatively. For the smaller minority of malignant lesions, accurate characterization with early triage to a gynecological oncology centre has an impact on oncological outcomes, and reduces the risk of re-operation and the time to initiation of adjuvant chemotherapy.[3] Conversely, inappropriate surgical triage of benign masses can have an adverse impact on patient morbidity, compromise fertility, and increase cause-specific death for a variety of conditions, including a range of malignancies and cardiovascular diseases.[4]

Finally, appropriate triage also minimizes the utilization of finite healthcare resources by ensuring that surgery is performed only when it is indicated and avoiding unnecessary follow-ups

and repeated imaging for benign or physiological categories of adnexal lesions.

Ultrasound remains the primary modality used for the characterization and initial assessment of adnexal masses.[5] It is non-invasive, cost effective, and has a high sensitivity and specificity. Transvaginal ultrasound (TVUS) has a sensitivity of 90% and a specificity ranging from 51–97% for detecting malignancies.[6,7]

There has been an increased emphasis on improving the clarity and communication in imaging reports by minimizing the use of ambiguous terminology such as "complex" or "heterogenous" mass, which can be unhelpful to the clinician responsible for triage. Various societies have encouraged the standardized management, reporting, and classification of adnexal masses.[4,7]

The experience and overall expertise of the radiologist performing the US, impacts the accuracy and quality of the assessment. Multiple studies have shown scoring systems using standardized reporting templates and nomenclature can equalize or improve the performance of a novice/relatively inexperienced radiologist to that of a more experienced radiologist.

Role of US; Performance Characteristics

As recommended by multiple guidelines,[5,8] US remains the initial test of choice for assessment. Its numerous benefits include cost effectiveness, safety, patient tolerance, lack of ionizing radiation, wide availability, and the ability to readily discriminate between cystic and solid lesions. Many physiological and benign lesions can be confidently diagnosed by US/TVUS. Additionally, US remains the modality of choice for the routine follow-up of benign lesions, as clearly detailed in the Ovarian-Adnexal Reporting and Data System (O-RADS) management recommendations.

With a sensitivity ranging from 88–100%, a negative ultrasound can confidently exclude malignancy. However, its specificity is variable, ranging from 46–95%, and is dependent on the imaging features and interpretation method.

Data has shown that the pattern recognition approach used by an experienced radiologist/sonographer is one of the most accurate means of discriminating between benign and malignant adnexal masses.[6] However, in real life settings there is a wide variance in the expertise of radiologists who perform and interpret these exams. Maintaining this level of expertise also requires exposure to a broad number and complexity of cases.

What Are We Looking For?

Risk categorization on US relies on the accurate recognition of specific imaging features. A stepwise approach is adopted when evaluating an adnexal finding on US. Benign lesions as well as physiological findings such as follicles or a corpus luteum can be readily characterized by "classic" lexicon features. Any findings outside these categories are classified as "lesions". Further sub-classification requires determining if a lesion is cystic or solid. For cystic lesions, further categorization is based on features such as locularity, mural irregularity, and the characteristics of septations if present. Solid components of cystic lesions include the presence and number of papillary projections (with >4 projections conferring additional risk). For solid lesions, features such as the outer contour (smooth versus irregular), colour score, and shadowing help in assigning a risk category. The presence of ascites and peritoneal nodularity automatically upgrades a lesion to a higher category, unless there is an alternate explanation for the ascites (cardiac failure). In general, increasing soft tissue components and higher vascularity are associated with a higher risk of malignancy. Vascularity is quantified within the solid tissue or wall of a lesion with a colour score ranging from 0 (no flow) to 4 (strong flow).

These findings are then categorized based on menstrual status (pre- or post-menopausal) and lesion size.

What is Standardized Reporting?

Synoptic reporting in radiology is used across a variety of body systems and has eliminated ambiguity in reports, facilitating clear communication, and providing guidance with management.

Several US-based classification systems have been developed for evaluating adnexal masses. These systems rely on morphologic features along with supporting clinical data.

The **IOTA** (**International Ovarian Tumour Analysis**) group conducted the largest study on the sonographic diagnosis and pre-operative classification of adnexal masses. This study paved the way for using standardized terms,

definitions, and measurements for these lesions. In particular, this database helped in testing existing models such as the Risk of Malignancy Index and compiling evidence-based terms and definitions to develop several risk-based models. Of these, the **Simple Rules** and the Assessment of Different NEoplasias in the adnexa (**ADNEX**) **model**[9-11] are the most widely recognized. The IOTA Simple Rules use 10 US features to classify lesions as either benign or malignant. However, approximately 20% of lesions cannot be classified by this method and require additional input such as an evaluation by an expert imager. The Simple Rules have a sensitivity of 91–96% and a specificity of 68–93%. These imaging features have been incorporated into a mathematical model that calculates the likelihood of malignancy. The ADNEX model uses additional information (menopausal status, CA-125 levels, and referral to a tertiary centre) along with 6 US features. It can further stratify risk into categories such as borderline, Stage I vs Stage II-IV malignancy, as well as metastases. With a 10% cut off, it has a sensitivity of 10% and a specificity of 71.3%, outperforming the Simple Rules (AUC 0.92 vs 0.95 for the ADNEX model).

O-RADS[12] was published in 2018 as a lexicon followed by the full system in 2019. This system was developed by a multi-disciplinary team of radiologists, gynecologists, and gynecologic oncologists. It incorporates a standardized lexicon for ovarian and adnexal lesions and provides a numerical score to enable risk assignment based on radiological features to determine the risk of malignancy. O-RADS includes both US and magnetic resonance imaging (MRI) components.

Moreover, it provides evidence-based guidance on management options for each risk category. This system was built on the foundational work of the IOTA group and extrapolated data and US descriptors from those trials to provide the framework for the O-RADS classification. Specifically, data from the IOTA phase 1–3 studies was reflected in this analysis, which included 5905 patients who had pathologically confirmed adnexal lesion(s). The most predictive descriptors identified in the IOTA studies were matched to the O-RADS US terminology.

Terminology such as “unilocular/multi-locular cyst ± solid components” and “mostly solid” were used to define the major categories of the adnexal lesions in O-RADS (See **Table 1**). This approach enabled the unification of a pattern-based approach (seen in North America) with the statistical data obtained from the IOTA studies and was predicated on the prevalence of malignancy in this subgroup of patients.

Numerical Score	Category Risk Assessment	Risk of Malignancy *(% or Range)*
0	Incomplete	NA
1	Physiologic (normal)	0
2	Almost certainly benign	<1%
3	Low risk	1-10%
4	Intermediate risk	10-<50%
5	High risk	≥50%

Table 1. O-RADS v2022 risk assessment categories and risk of malignancy; *adapted from O-RADS US v2022: An Update from the American College of Radiology’s Ovarian-Adnexal Reporting and Data System US Committee.*

How Does O-RADS Work?

O-RADS is divided into 6 risk stratification categories ranging from 0–5. Category 0 applies to an examination that is technically inadequate. Categories 1–5 describe a range of lesions from physiological/normal findings to those with a high risk of malignancy. O-RADS US terminology incorporated the most predictive descriptors from the IOTA data and classifies each descriptor into a risk category. Each risk category is then subsequently assigned a corresponding recommendation for management. Again, this approach facilitates interpretation, but also provides clear guidance for the non-expert clinician/healthcare provider who may be managing or triaging an adnexal mass. The system is designed to be applicable to a general population with an low overall prevalence of malignancy. It is designed to optimize sensitivity at the expense of specificity, given the lethality of ovarian malignancy. Additionally, the number of

false negatives is minimized. Version 2022 of the O-RADS system[13] was introduced to incorporate emerging data and address features that improve specificity for lesions of lower risk.

When and How Should It Be Used?

It is recommended to apply O-RADS to all adnexal masses, whether physiological or otherwise. Certain governing concepts[13] or rules are applied. Note that management guidance is based on patients who are at average risk and asymptomatic. The original IOTA data group, however, included patients who were symptomatic and of high risk. Therefore, the lexicon terminology and categorization apply to these patients, but management recommendations may need to be individualized. While a full description of these rules is beyond the scope of this article, certain broad concepts still apply.

1. **Applicability criteria:** relevant only to lesions of ovarian or tubal origin. Therefore, if there is a lesion of uncertain origin, (e.g., an exophytic fibroid), O-RADS does not apply. Additional imaging, either with computed tomography (CT) or MRI, may be necessary to determine the compartment of origin. In certain clinical settings (unrelated to malignancy) the O-RADS system does not apply (for instance in the context of pelvic inflammatory disease or an ovarian torsion). In the context of bilateral adnexal masses, each mass is scored independently, with the higher scoring lesion driving the management approach.

2. **Definitions and technique:** the 2022 version has further sub-divided the menopausal status of patients into early and late stages to assist with the management of hemorrhagic cysts. In addition, there is clarification regarding the role of US specialists. The necessity for a TVUS has been negated in this version, as the trans-abdominal technique is considered sufficient when TVUS is either not technically feasible or inadequate in scope.

   Finally, users are encouraged to record 3 dimensions as an average linear dimension to allow an accurate comparison between serial examinations and assess for interval changes.

3. **System use rules:** although O-RADS risk assessment scoring can be applied to the majority of lesions irrespective of patient risk factors and symptoms, management may differ in these clinical scenarios.

Role of MRI Relative to US

Where does MRI fit into the imaging paradigm for risk stratification? There are advantages to imaging adnexal masses on MRI, (discussed below) however, it is also important to acknowledge the resource limitations within the Canadian healthcare system. MRI remains an expensive modality, and access to this resource is limited with long wait times.

MRI offers superior specificity and accuracy compared with US. It not only aids in characterizing benign lesions (in the atypical US scenario), but also provides greater soft tissue contrast and characterization. MRI has a high positive predictive value (PPV) for the exclusion of malignancy (71%) and a high negative predictive value (NPV) (98% vs 99% for US). Similar to US, it is a radiation free modality.

Applying a US-based stratification system allows for accurate classification and risk assignment in the majority of cases. However, 5–25% of lesions remain indeterminate on US.[14] In these circumstances, the PPV for malignancy varies between 7–50%. Additionally, there are circumstances in which US may be limited for technical reasons (e.g., patient habitus, inability to tolerate a TVUS). TVUS is not mandatory for lesion characterization, but it does impact the ability to accurately characterize lesions. When pelvic masses are large (e.g., >10 cm) US may be more limited in determining their origin as well as optimally assessing specific features such as the presence of mural irregularity or nodules. In this setting, MRI allows a clearer assessment. Finally, it is easier to demonstrate vascularity/enhancement in the smaller solid components of cystic lesions with MRI than with ultrasound.

The O-RADS MRI system, developed in tandem with the US-based system, was launched in 2021. Akin to the US-based system, it uses morphologic and functional findings on MRI to assign a risk score for adnexal masses. Further discussion of this topic is beyond the scope of this article.

What is the Role of Other Modalities?

CT plays no role in the work up or characterization of adnexal masses. However, in the setting of a presumed or proven malignant mass, contrast enhanced CT is a first line modality for staging and surgical planning to determine if a patient should be triaged to surgical debulking or neoadjuvant therapy.

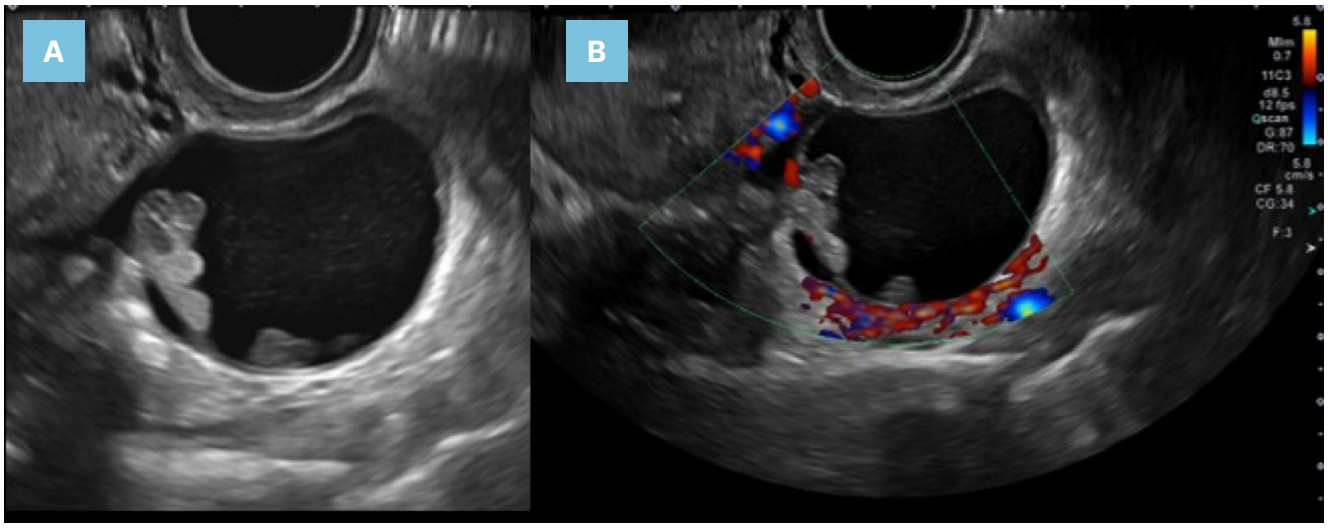
Current Status of O-RADS and Emerging Literature

Since the publication of O-RADS numerous publications and retrospective studies have been conducted in a variety of practice and population settings to assess its performance and accuracy, and to compare it with existing systems. Diagnostic accuracy in these studies has shown an AUC ranging from 0.91–0.98.[15-19] Most studies have shown that O-RADS has a pooled sensitivity and specificity of 95% and 82% on US, and 95% and 90% on MRI, respectively. The majority of these studies have used a cut off of O-RADS category 4 and above for the detection of cancer. These studies all reinforce the significant inter-observer agreement, irrespective of training and/or level of experience. However, in most instances, there was an initial training phase. Studies have also favourably matched the risk of malignancy in most categories, except for O-RADS category 3 and O-RADS category 4, where the malignancy rate is at the lower limit of each category.[16,18]

Take Home Points

Standardized reporting using a classification system is the best method for triaging adnexal masses on imaging. The O-RADS system is highly validated and demonstrates reproducibility and accuracy across a range of studies. Further ongoing refinements to this system are expected to continue improving the specificity and performance in risk categorization.

Locally, our evidence-based review in Ontario endorsed O-RADS as a system for the reporting and management of adnexal masses. Accompanying literature and guidance documents were published to facilitate its adoption in the Canadian healthcare context.



Brief Case Study: 33-year-old patient with dysfunctional uterine bleeding. TVUS greyscale **(A)** and color doppler images **(B)** demonstrate the presence of an adnexal mass measuring 4.8 × 4.8 × 3.4 cm. Utilizing ORADS, this lesion conforms to an ORADS category 5 lesion as it is a unilocular cyst with > 4 papillary projections. Color score is not relevant in this instance. The risk of malignancy is therefore >50%. The patient was triaged to gyne-oncology. Pathology confirmed a borderline serious neoplasm; *courtesy of Tanya Chawla, MD.*

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Financial Disclosures

None declared.

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