Review Article

Imaging and diagnostic approach of the adnexal mass: what the oncologist should know

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Abstract: Early detection and characterization of ovarian lesions is of utmost importance for adequate management. Ovarian cancer accounts for 3.3% of all cancers in women worldwide but has only a 5% of female cancer deaths because of low survival rates. The majority of ovarian lesions are benign and have spontaneous resolution. The adequate discrimination between benign and malignant lesions is the most important starting point for a correct and optimal management. Ultrasound is the method of choice up until now for adequate assessment of adnexal abnormalities, no other method has proven superior. Along time, there has been many classification systems that aim standardization of adnexal masses The Gynecology Imaging Reporting and Data System (GI-RADS), published in 2019. The International Ovarian Tumor Analysis (IOTA) group standardized in 2013 the approach of adnexal pathology descriptions by ultrasound with the limitation of needing pathologic reports for complete assessment. The Ovarian Adnexal Reporting and Data System (O-RADS) is a lexicon designed in 2018 to standardize definitions of characteristics by ultrasound. This system offers an interpretation method to decrease ambiguity and recommends management guides according to its classification.

Keywords: Adnexal mass; International Ovarian Tumor Analysis (IOTA); Ovarian Adnexal Reporting and Data System (O-RADS); ovarian cyst; ovarian cancer

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Introduction

Early detection and characterization of ovarian lesions is of utmost importance for adequate management (1,2). Ovarian cancer accounts for 3.3% of all cancers in women worldwide but has only a 5% of female cancer deaths because of low survival rates (1). Its late detection, due to the fact that early ovarian cancer is usually asymptomatic, causes advance disease and high mortality rates (3). The lifetime risk of having ovarian cancer accounts for 1.3% which is 1 in 78 women (2). In developed countries incidence of ovarian cancer is higher and represents the gynecological tumor with the greatest mortality rate (*Table 1*). Never the less, incidence has dropped overtime from a 29% documented in 2014 to a 6.6% in 2018 (2,5). Higher risks of developing ovarian cancer are associated with menopausal hormone use (20% higher), while using oral contraceptives, having a higher parity, tubal ligation and oophorectomy are associated with lower risks (3).

The majority of ovarian lesions are benign and have spontaneous resolution (4).

The adequate discrimination between benign and

Table 1 Estimated incidence and mortality of ovarian cancer in 2018

Region	Incidence*	Mortality*
Worldwide	295,414	184,799
Asia	153,076	92,257
Europe	67,771	44,576
Africa	27,194	16,702
North America	23,285	15,862
Latin America and the Caribbean	21,925	13,668
Oceania	2,163	1,464

*, number of cases. Source—reference (4).

Table 2 Evolution of adnexal mass classification systems throughout time

Period	Adnexal mass classification system
1993	Kentucky Morphology Index
2000	IOTA terms
2008	IOTA simple rules
2010	SRU
2011	GI-RADS
2014–2017	First international consensus on adnexal masses
2015–2018	O-RADS US
2015–2019	ADNEX model
2019	SRU redefine simple cysts
2019	Incidental findings CT & MR for simple cysts
2019	O-RADS MRI introduction (RSNA 2019)

Source—References (10-13).

malignant lesions is the most important starting point for a correct and optimal management (6). The goal of an early diagnosis is to reduce unnecessary surgical procedures and minimize unfavorable ovarian cancer outcomes. In contrast with other neoplasms, adnexal masses should not be biopsied, thus making imaging findings is crucial for diagnosis and management (3,4).

Ultrasound is the method of choice up until now for adequate assessment of adnexal abnormalities, no other method has proven superior (6,7) The American College of Radiology (8) classifies duplex ultrasound, ultrasound pelvis transvaginal and ultrasound pelvis transabdominal as usually appropriate for diagnosis of non-acute adnexal masses in all of its categories (9). When a cystic unilocular lesion is found, the risk of it evolving into malignancy is low, in premenopausal woman it represents less than 1% and 1.6% in postmenopausal women (9).

Along time, there has been many classification systems that aim standardization of adnexal masses (*Table 2*).

The Gynecology Imaging Reporting and Data System (GI-RADS), published in 2019, concluded that their classification system of diagnosis of adnexal masses by ultrasound has a high reliability with a sensitivity and specificity of 92.9% and 97.5% respectively (7). This classification also provides a risk of malignancy and is useful for clinical decisions (7).

The International Ovarian Tumor Analysis (IOTA) group standardized in 2013 the approach of adnexal pathology descriptions by ultrasound with the limitation of needing pathologic reports for complete assessment.

The Ovarian Adnexal Reporting and Data System (O-RADS) is a lexicon designed in 2018 to standardize definitions of characteristics by ultrasound. This system offers an interpretation method to decrease ambiguity and recommends management guides according to its classification (1,14). The stage of ovarian cancer is given by International Federation of Gynecology and Obstetrics (FIGO), Tumor Node Metastasis (TNM) and American Joint Committee of Cancer (AJCC). In FIGO the most common stage of detection is FIGO III (3).

This review is not an encyclopedic review of adnexal masses and does not encompass every pathologic entity that may present and ovarian mass. It provides a practical introduction to the most recent classifications and imaging techniques for a correct approach of a suspected ovarian mass.

Pathology

Primary ovarian cancer can be classified as epithelial and non-epithelial with the first one being the most common. Nonepithelial neoplasms are less aggressive than epithelial ones. Usually epithelial tumors occur in patients older than 20 years and malignancy rates increase with age (3). The mature cystic teratoma is the most common benign ovarian tumor, usually occur in in younger women (3).

The World Health Organization Histological Classification (8) classifies ovarian cancer as surface epithelial (65%), germ cell (15%), sex cord-stromal (10%), metastases (5%) and other (10). Surface epithelial carcinomas are

subclassified in serous (52%), mucinous (6%), endometroid (10%) clear cell tumors (6%) transitional cell tumor and epithelial-stromal tumors (10). Transitional cell tumors are divided in Brenner tumor, Brenner tumor of borderline malignancy, malignant Brenner tumor and Transitional cell carcinoma (non Brenner type). Epithelial- stromal tumors are divided in adenosarcoma and carcinosarcoma. The rest of the surface epithelial tumors are classified into benign, malignant and borderline (2,3,10).

Sex cord-stromal tumors are subclassified into Granulosa tumors (fibromas fibrothecomas and thecomas), Sertoli Cell tumors (Leydig cell tumors), Sex cord with annular tubules, gynandroblastoma and steroid cell tumors (2,10).

Germ cell tumors include teratomas (immature, mature, solid and cystic), monogermal, dysgerminoma, Yolk sac tumor and mixed germ cell tumors (2,10).

Malignant or not otherwise specified tumors are metastatic lesions with a most frequent source coming from colonic, gastric or breast primary tumors (3,10).

Although multiple screening trials for detecting early stage ovarian cancer in asymptomatic postmenopausal women have been conducted, to date none of them has shown benefit in terms of survival (1,2). On the other hand, screening in high-risk groups is recommended (6).

The main objective of the evaluation of ovarian masses is the diagnosis or the exclusion of malignancy, to minimize unnecessary surgical procedures in benign lesions, and to optimize ovarian cancer outcomes by the opportune referral to a gynecologic oncologist in the malignant lesions (2,3,11).

Ultrasound

Ultrasound is a fundamental tool in the assessment of adnexal lesions and along with clinic history and serum tumor markers (3), helps to triage women into risk management categories (5,9,12). To date, ultrasound is the modality of choice for the initial approach of a suspected ovarian tumor.

Transvaginal ultrasound has a sensitivity of 90% and a specificity of 51–97% for detecting malignancy (9,13). The degree of suspicion is based largely on the imaging features.

Ultrasound examination remains as the first-line imaging technique for the evaluation of ovarian disease (13,15), it is cost effective, noninvasive, well-tolerated and widely available. In general, the use of transvaginal ultrasound is preferred over transabdominal ultrasound, but its limitations come with its limited field of view that may result in failure to entirely visualize the uterus, ovaries or masses lying higher in the pelvis; in these cases, the evaluation may be followed by a brief transabdominal ultrasound (15).

Table 3 IOTA simple descriptors

Benign descriptors
Unilocular tumor with ground-glass echogenicity in premenopausal women
Unilocular tumor with mixed echogenicity and acoustic shadows in premenopausal women
Unilocular anechoic tumors with regular walls and largest diameter lesion of <100 mm
Unilocular tumor with regular walls
Malignant descriptors
Tumors with ascities, moderate Doppler bloodflow in postmenopausal women. Women >50 y.o. CA-125 >100 IU/mL

Mayor groups have developed imaging criteria and prediction models for characterization of adnexal masses: the IOTA, The Society of Radiologists in Ultrasound (16), the First International Consensus Report on Adnexal Masses and most recently O-RADS (1,4), among others.

The largest diagnostic accuracy study regarding sonographic differentiation of the benign or malignant nature of and adnexal mass was the IOTA study (17,18).

The IOTA group has proposed a three-step strategy to improve the adnexal mass assessment. First step is using Simple Descriptors by pattern recognition. Second step, IOTA Simples Rules and third step a subjective assessment of an expert radiologist. This method has been proven to be the one with the best sensibility and specificity to classify adnexal masses (19).

IOTA "Simple Descriptors"

Also known as easy instant diagnosis, consist of six specific ultrasonographic patterns that correspond to specific adnexal pathologies and measurements of serum CA-125 in 50-year old or older patients (see *Table 3* and *Figure 1*) (19).

If none of them is applicable, the mass is considered as "non-classifiable" or "non-instant". Would lead to the second step: IOTA Simples Rules (7,17) (*Figure 2*).

IOTA "Simple Rules"

The IOTA study, which began in 1999, is the largest study in the literature for the sonographic diagnosis and

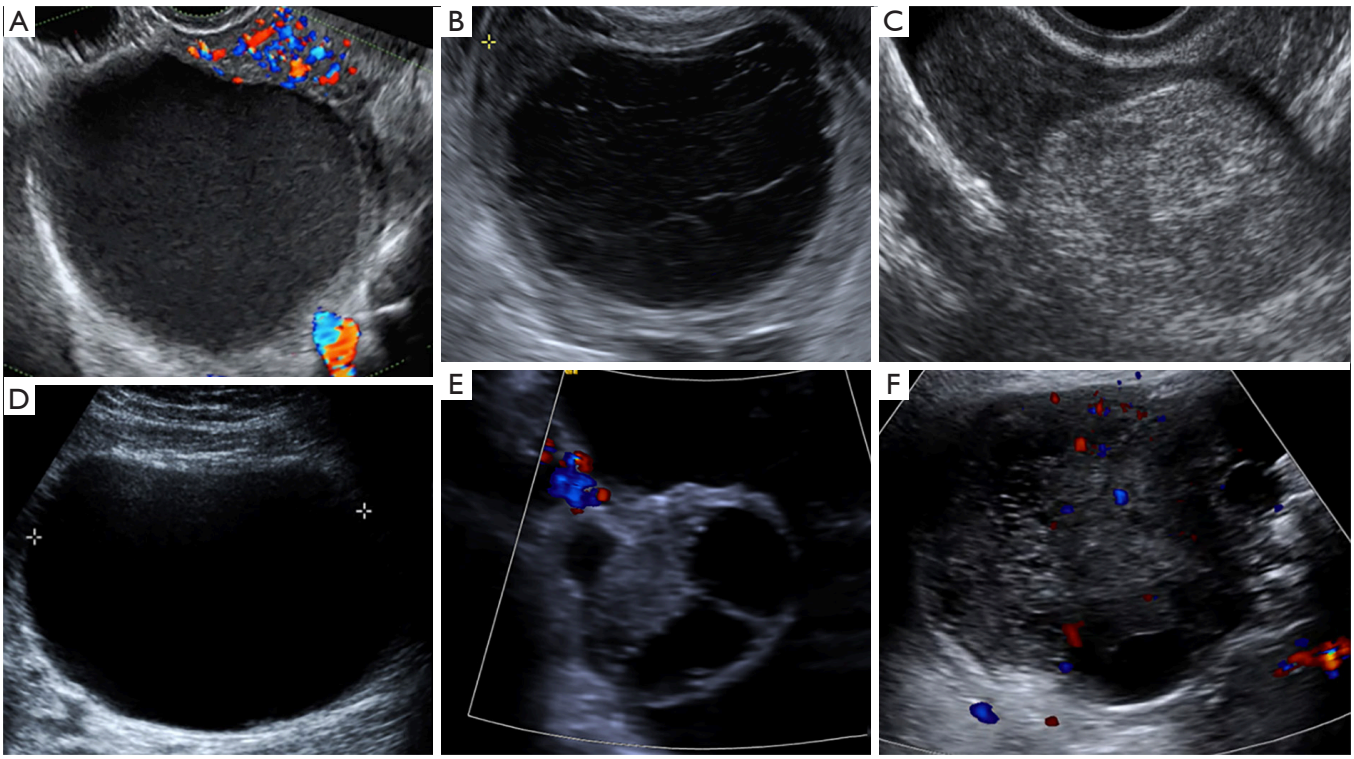


Figure 1 International Ovarian Tumor Analysis (IOTA) simple descriptor patterns. (A) BD unilocular tumor with ground-glass echogenicity consistent of endometrioma; (B) BD unilocular tumor with mixed echogenicity and acoustic shadows consistent with a hemorrhagic cyst; (C) BD unilocular tumor with regular walls consistent with a dermoid tumor; (D) BD unilocular anechoic adnexal mass with regular walls consistent with a functional cyst; (E) MD tumor with ascitis in a carcinosarcoma adnexal tumor; (F) solid tumor with moderate blood flow.

preoperative classification of ovarian masses.

The "Simple Rules" by IOTA study group were developed at 2008, they consist in a conjunct of five sonographic findings indicative of a benign lesion (B-features) and five sonographic findings indicative of a malignant lesion (M-features) (*Tables 4,5*, *Figures 3-5*).

According to this Simple Rules, an ovarian tumor is benign if only B-features are present and malignant if only M-features are present. If both features apply, or no features are present, the lesion cannot be categorized.

The Simple Rules has a sensitivity of 91–96% and 68–93% of specificity when performed by inexperienced sonographers (20) diagnosing 75% of adnexal masses. The third step is for the left 25% inconclusive lesions, which is to refer the case to an expert sonographer or to a gynecology oncologist as 40% of the inconclusive cases would ultimately prove to be malignant (21).

Garg *et al.* published in 2017 the values of sensitivity and specificity previously mentioned, and an accuracy of 88% when the inconclusive cases were classified as malignant (20).

The Society of Radiologist in Ultrasound (16) consensus [2019]

In 2019, the Society of Radiologist in Ultrasound published its second systematic guideline consensus (first published in 2010) for the management of simple ovarian cysts. These guidelines were designed to be applied in asymptomatic patients and in patients with symptoms not attributable to the ovarian lesion, as a method to share expertise.

In recent studies, the low risk of malignancy of simple ovarian cysts has been demonstrated, irrespective of their size.

The majority of the small simple cyst do not need follow-up. If a cyst is not very-well characterized a second opinion ultrasound or follow-up is recommended, to warrant that a solid part is not being missed. It also helps to assess the rate growth of cysts (22).

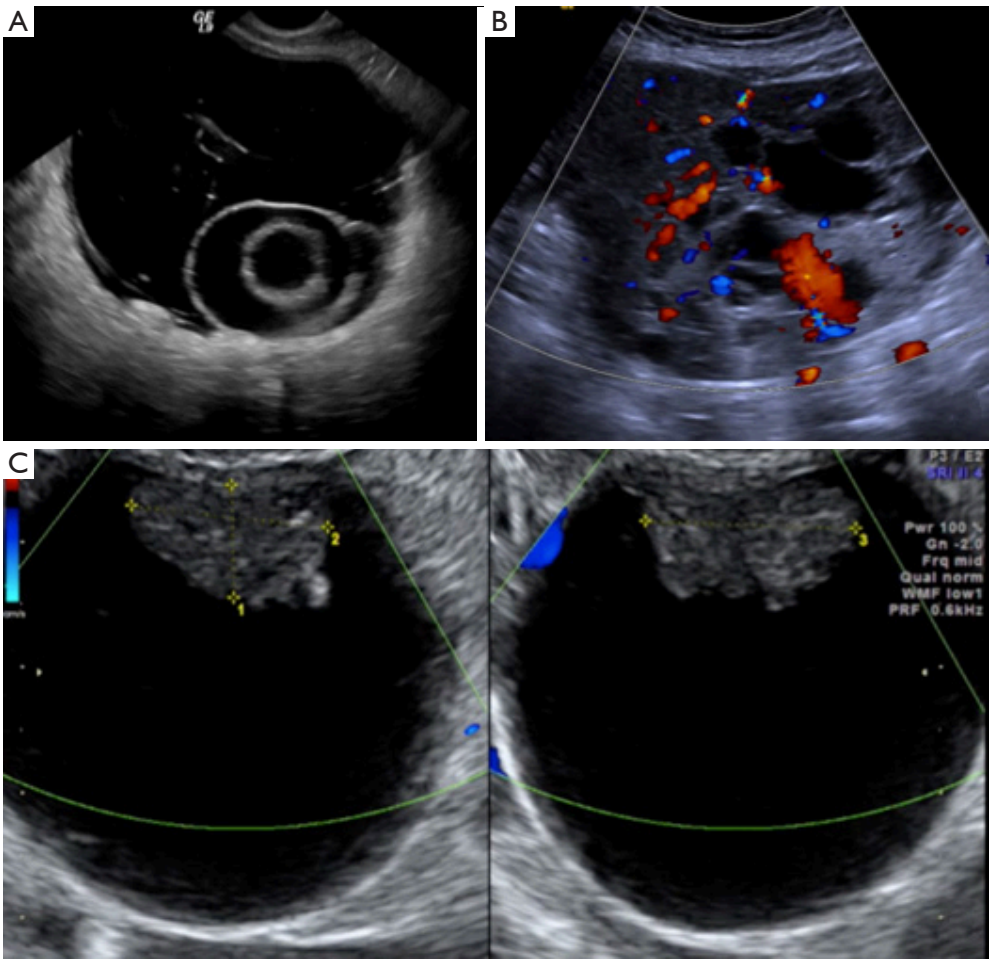


Figure 2 Transvaginal adnexal ultrasound of two patients classified after International Ovarian Tumor Analysis (IOTA) criteria. (A) Multilocular left ovarian tumor with less than 10 cm in diameter. Benign features: (B) solid and cystic adnexal mass, highly vascularized ovarian tumor. Malignant features: (C) cystic lesion with a solid papillary projection greater than 7 mm. Indeterminate lesion.

A simple cyst must meet the following characteristics in order to be named as such: anechoic, with thin and smooth walls, unilocular, no internal Doppler flow and has to be entirely evaluated.

If there is doubt that a cyst is simple or not, it should be followed to assess growth, if it decreases in size and remains as a simple cyst, it is no longer necessary to follow it, due to its low possibility of malignancy. A follow-up two years later, will confirm this assertion.

If the simple cyst increased in size, then it is most likely a cystadenoma. It is suggested to follow it by ultrasound and clinically for two years to assess the growth rate.

The larger the cyst size, the greater the risk of missing solid parts. To date, there is no consensus for this size threshold, so the O-RADS size thresholds are currently used for the follow-up of cysts with suboptimal characterization (22) (*Figures 6*,*7*).

First international consensus report on adnexal masses: management recommendations [2014–2017]

It was the first collaborative international multidisciplinary consensus. They established that it was appropriate to use pattern recognition or algorithm approaches (simple rules at that time) and if the lesion is still indeterminate, proceed to the second steps: referral to expert sonographers, serial ultrasound, application of established risk models, referral to MRI o to gynecology oncologist management.

They also added the clarified that simple ovarian cysts are not precursors to malignant ovarian carcinoma and they

Table 4 Five malignant features

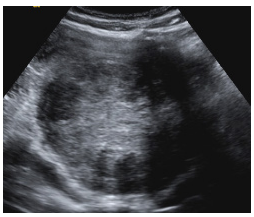
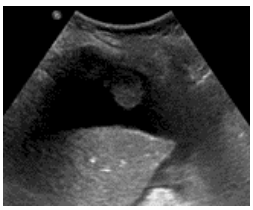
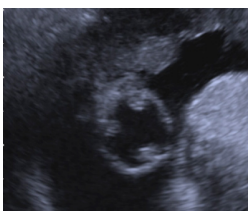
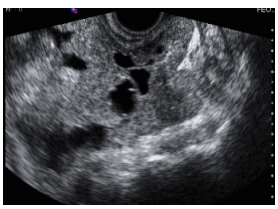
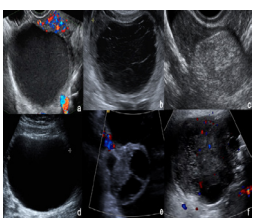
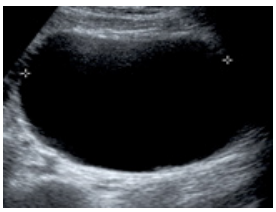
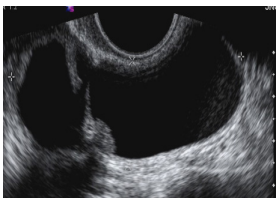
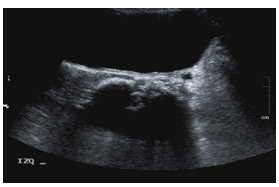
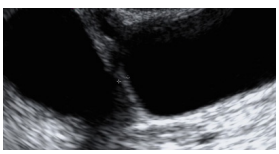
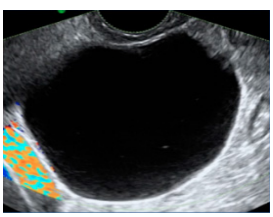
Abbreviation	Description	Example
M1	Irregular solid tumor	
M2	Presence of ascitis	
M3	At least 4 papillary structures	
	Irregular multilocular solid tumor with largest diameter over 10 cm	
	Very strong color Flow (CS 4)	

Table 5 Benign features

Abbreviation	Description	Example
B1	Unilocular cyst in any size	
B2	Solid components either not present or less than 7 mm in diameter	
B3	Presence of acoustic shadowing	
B4	Smooth multilocular tumor with largest diameter less than 10 cm	
B5	No blood flow (CS 1)	

raised the size threshold for follow-up simple cysts to 10 cm.

ADNEX model (IOTA group) 2015—current

The ADNEX model is a risk prediction model than can distinguish between benign, borderline, stage I invasive, stage II–IV invasive, and secondary metastatic adnexal ovarian tumors. It is a risk prediction model that uses 9 predictors (*Figure 8*):

- Three clinical features: Oncologic vs nononcologic center, serum cancer antigen 125 (Ca-125) level and the age of the patient;
- Six ultrasound predictors: maximum lesion diameter, maximum soft tissue diameter, >10 locules, number of papillary projections, acoustic shadowing, ascites (20).

O-RADS

O-RADS risk stratification and management system by the American College of Radiology (8) was created to unify interpretations and reduce ambiguity in the management

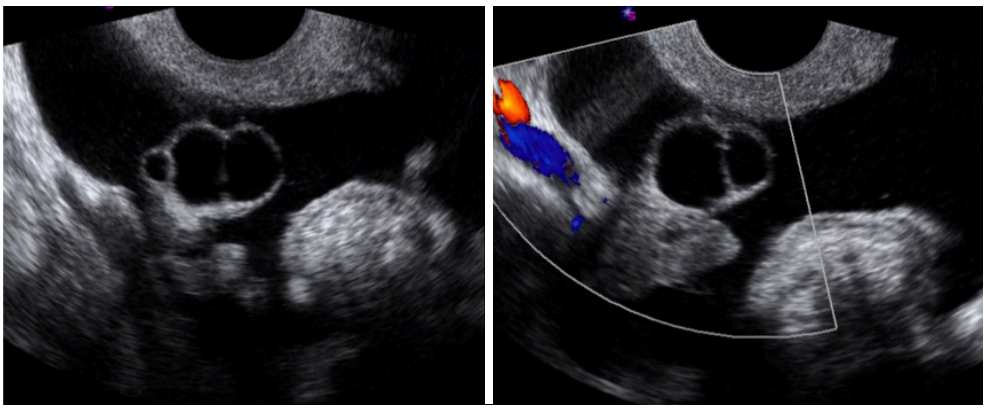


Figure 3 Smooth multilocular cyst, largest diameter <10 cm (B4), with no internal flow (B5) or solid components. Ascites secondary to a condition unrelated to the ovaries.

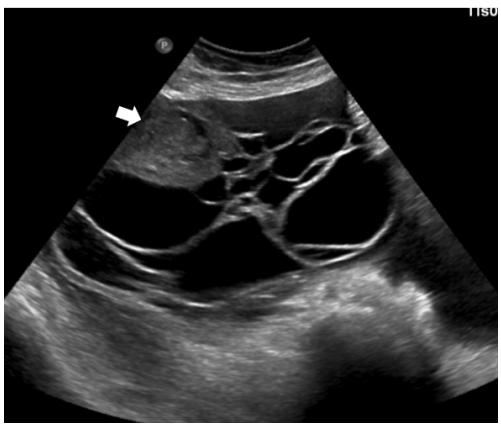


Figure 4 M4: irregular, multilocular solid (arrow) tumor with largest diameter >10 cm in a cystadenocarcinoma.

and classification of adnexal masses.

This system includes the pattern-based approach and algorithm IOTA-ADNEX model system; it consists in a system of six categories (0 to 5). Each of these categories shows an estimated risk percentage of malignancy and provides management recommendations (follow-up, treatment, referral, etc.) for each risk group, divided into pre and postmenopausal patients, defining this last category as women with a year or more of amenorrhea (1).

Considerations

These recommendations have been published to guide management of women with low-average risk of ovarian cancer, who are asymptomatic and have an ovarian lesion.

These guidelines are not a rule, and cases should be individualized by professional judgement as needed.

The size of the ovarian lesion will be determined according to its largest diameter.

O-RADS applies only to lesions involving the ovaries or fallopian tube.

The recommendations given by O-RADS are based on transvaginal ultrasound, although they may be complemented by transabdominal ultrasound if needed (1).

The O-RADS categories are described next (*Figure 9*).

Recommendations

Until now, no system has been able to fully include all aspects of the management of ovarian lesions. The O-RADS ultrasound system attempts to unify, standardize and define more clearly when referring a patient, the follow-up and management, increasing the sensitivity (not the specificity) to reduce the amount of undiagnosed ovarian cancers, since it has a high mortality rate (1).

The largest diagnostic accuracy study regarding sonographic differentiation of benign and malignant adnexal masses was the IOTA study (17).

- RADS 0: incomplete evaluation, it may due to technical factors or inability to tolerate endovaginal imaging.
- RADS 1: normal premenopausal ovary (physiologic category). This category is important just in premenopausal women. It comprehends ovarian follicle and corpus luteum, and they should be described as so, rather than cysts.
- RADS 2: almost certainly benign (<1% risk of

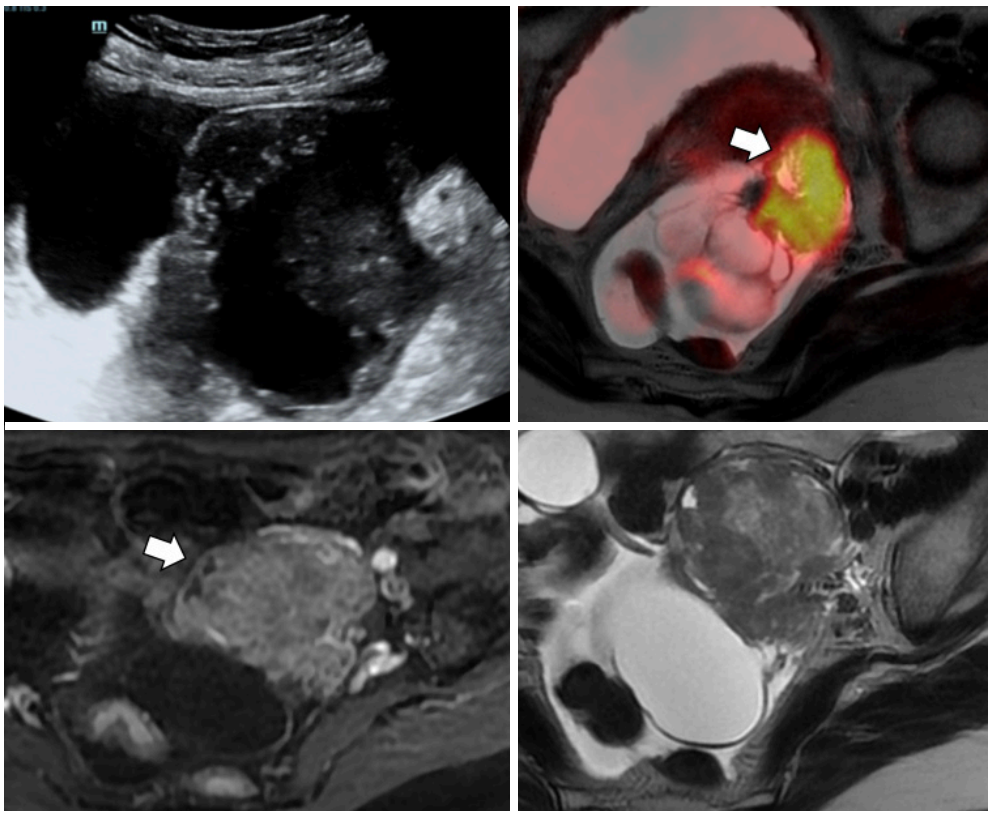


Figure 5 Irregular multilocular-solid tumor with largest diameter >10 cm (M4). PET/MRI and MRI acquisitions show hypermetabolism and heterogeneous post-contrast enhancement in the solid portion of the lesion (arrow) corresponding to a high-grade serous carcinoma.

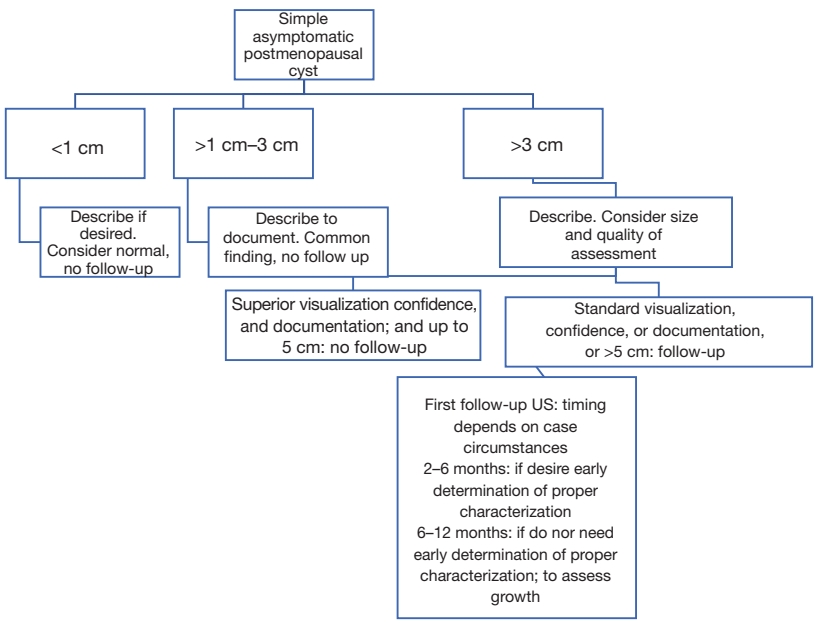


Figure 6 Flowchart showing recommendations for simple cyst management in postmenopausal women according to the SRU 2019 management in postmenopausal women according to the SRU 2019 consensus.

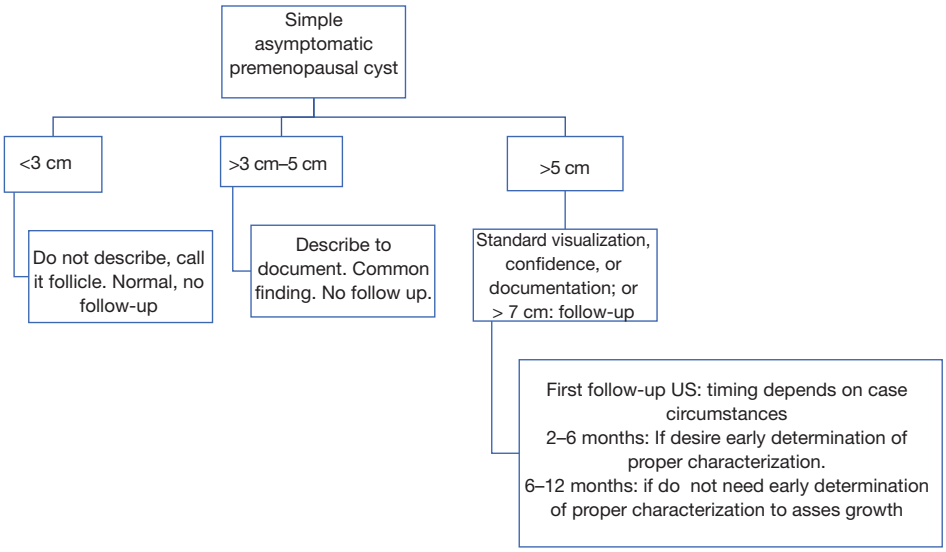
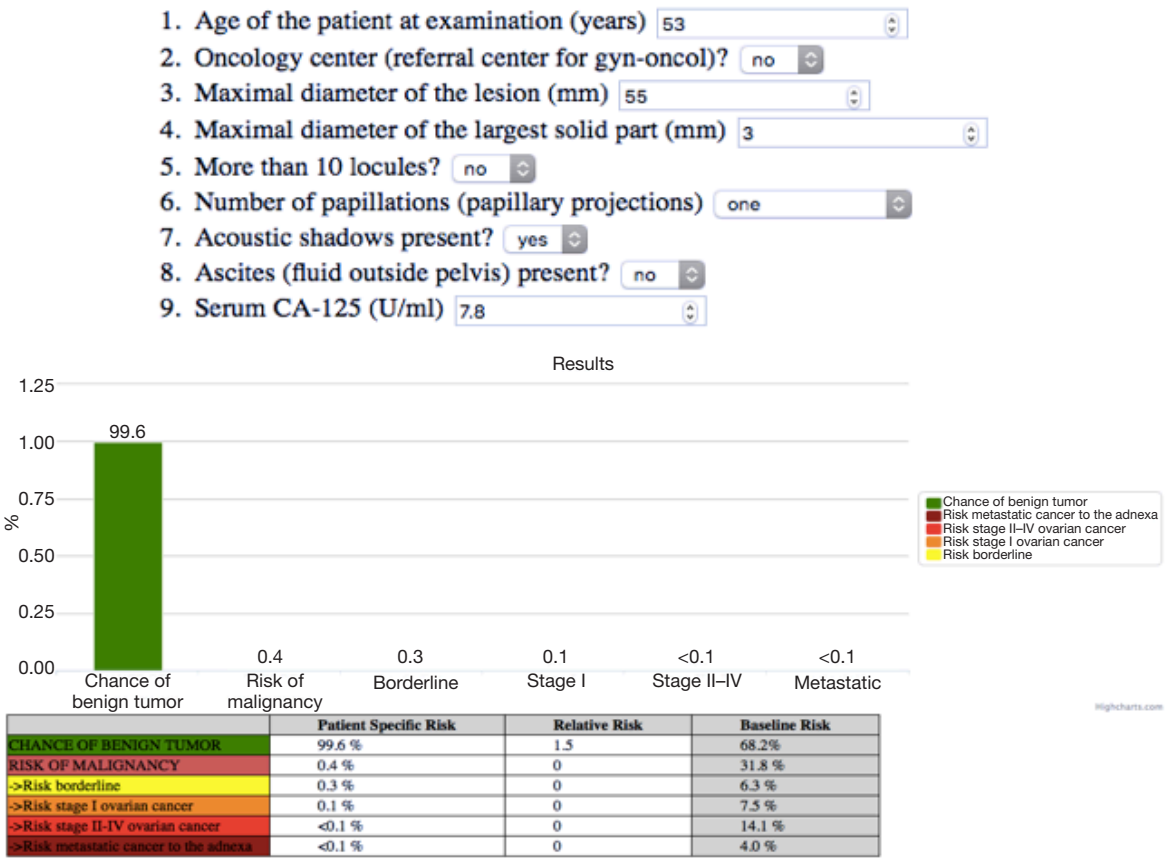


Figure 7 Flowchart showing recommendations for simple cyst management in premenopausal women according to the SRU 2019 consensus.



	Patient Specific Risk	Relative Risk	Baseline Risk
CHANCE OF BENIGN TUMOR	99.6 %	1.5	68.2%
RISK OF MALIGNANCY	0.4 %	0	31.8 %
->Risk borderline	0.3 %	0	6.3 %
->Risk stage I ovarian cancer	0.1 %	0	7.5 %
->Risk stage II-IV ovarian cancer	<0.1 %	0	14.1 %
->Risk metastatic cancer to the adnexa	<0.1 %	0	4.0 %

Figure 8 An example of the mathematical risk prediction IOTA-ADNEX model, showing the average risk of malignancy or benignity of an ovarian tumor, based in clinical and ultrasound criteria. Taken from: www.iotagroup.org/sites/default/files/adnexmodel

A

O-RADS score	Risk category (IOTA model)	Lexicon descriptors Pre-menopausal		Management	
				Post-menopausal	
0	Incomplete evaluation	N/A		Repeat study or alternate study	
1	Normal ovary	Follicle: simple cyst up to 3 cm		None	N/A
		Corpus luteum up to 3 cm			
2	Almost certainly benign (<1%)	Simple cyst	Up to 3 cm	N/A	None
			>3–5 cm	None	Follow-up in 1 year[¶]
			>5 but <10 cm	Follow-up in 8–12 weeks	
		Classic benign lesions	Typical: hemorrhagic cyst Dermoid cysts (<10 cm) Endometrioma (<10 cm) Paraovarian cyst (any size) peritoneal inclusion cyst and hydrosalpinx (any size)	Individual management (to more information see: O-RADS US risk stratification and management system for classic benign lesions and associated descriptors by the ACR	
		Non-simple unilocular cysts, smooth inner margin	Up to 3 cm	None	Follow-up in 1 year[¶] if concerning, US specialist or MRI
			>3 but <10 cm	Follow-up in 8–12 weeks if concerning, US specialist	US specialist or MRI

B

3	Low risk of malignancy (1% to <10%)	Typical dermoid cyst, endometriomas, hemorrhagic cysts >10 cm		US specialist or MRI management by gynecologist
		Unilocular cyst any size, with irregular inner wall <3 mm height		
		Multilocular cyst up to 10 cm, smooth inner wall, CS= 1–3		
		Solid smooth, any size, CS=1		
4	Intermediate risk (10% to <50%)	Multilocular cyst, no solid component	Up to 10 cm, smooth inner wall, CS=1–3	US specialist or MRI Management by gynecologist with gynecology oncologist consultation or solely by gynecology oncologist
			Any size, smoot inner wall, CS=4	
			Any size, irregular inner wall and/or irregular Septations, any color score	
		Unilocular cyst with solid component	Any size, 0–3 papillary projections, CS=any	
		Multilocular cyst with solid component	Any size, CS=1–2	
		Solid	Smooth, any size, CS=2–3	
5	High risk (>50%)	Uniocular cyst, any size, equal or >4 papillary projections, CS=any		Gynecology oncologist
		Multilocular cyst with solid component, any size, CS=3–4		
		Solid smooth. Any size CS=4		
		Solid Irregular, any size, CS=any		
		Ascites and/or peritoneal nodules[§]		

Figure 9 O-RADS US risk stratification and management system. [¶], at a minimum, at least 1-year follow-up showing stability or decrease in size is recommended with consideration of annual follow-up of up to 5 years, if stable. However, there is currently a paucity of evidence for defining optimal duration or interval of timing for surveillance. [§], presence of ascites with category 1–2 lesion, must consider other malignant or nonmalignant etiologies of ascites. CS, color score; GYN, gynecologic; IOTA, International Ovarian Tumor Analysis; N/A, not applicable. Adapted, from the American College of Radiology (11).

malignancy). Includes most of the unilocular cysts smaller than 10 cm. Comprises: simple cysts, non-simple unilocular cyst with smooth walls and cysts that may be described by using "classic benign descriptors", which are the following: typical hemorrhagic cyst, dermoid cysts, endometrioma, paraovarian cyst, peritoneal inclusion cyst and hydrosalpinx.

- ❖ RADS 3: low risk of malignancy (1% to <10%). In this group, the color score becomes incorporated into the risk stratification system.
- ❖ RADS 4: lesions with an intermediate risk of malignancy (10% to <50%). Need ultrasound specialist review or MRI as well as management by a gynecologist with gynecology oncologist support or solely by a gynecology oncologist.
- ❖ RADS 5: lesions with a high risk of malignancy (≥50%) Needs a referral to gynecology oncologist. This category, includes descriptors with high predictive value of malignancy, the presence of ascites or peritoneal nodules.

MR protocol for adnexal mass characterization

Various MR protocols have been used to evaluated ovarian lesion.

T1 weighted (T1W) images in axial plane without and with fat saturation. These are used to identify macroscopic fat and hemorrhage. T1W chemical shift imaging using dual in phase and opposed phase gradient echo (GRE) sequences in axial plane. This are used to confirm lipid and macroscopic fat (23).

T2 weighted (T2W) images in axial sagittal and coronal planes without fat saturation, for optimizing tissue characterization (23).

T1W contrast enhanced images using gadolinium are used to evaluate vascularity of soft tissues. In ovarian lesions it is important to recognize papillary projections, masses and nodules, or thick septations. Postcontrast imaging protocols include fat saturated multiphase imaging acquisitions during arterial and venous phases, and one or more delayed phases. Pre-contrast and post-contrast imaging should be performed with the coverage and scan parameters to enable imagen subtraction. Short acquisitions of 15 seconds repeated over a period of 3 to 4 should be done with acquisitions at 30, 90, 120 and 150 seconds (24).

It is also important to obtain diffusion weighted imaging (DWI) done at both low and high b values >b800 (25).

Contrast-enhanced MR is recommended for all indeterminate adnexal masses. This technique evaluates the leakage of contrast from capillaries into the extravascular extracellular space. These findings can be analyzed through three different approaches: descriptive, semi-quantitative and quantitative (26,27). A study performed by Mansour *et al.* used dynamic imaging parameters where they included kinetic curve analysis. Three patterns of plotted slope enhancement ratio curves were described: (I) continuous rise, (II) plateau and (III) early washout. The type I was detected in 35.3%; of these 68% proved benign, 15% had a low malignant potential and 17% were malignant with an invasive component. Type II was demonstrated in 24% of the cases. 16.7% were benign, borderline masses accounted for 22.2% and malignant masses were proved on 61% of the cases. Type III was found in 40.7% of the cases; 16.4% for borderline tumors and 83.6% for malignant ovarian masses (28).

ADNEX MR scoring system

MR has the best potential for preoperative evaluation of adnexal masses. Thomassin-Naggara *et al.* published the MR scoring system in 2013 with a sensitivity of 93.5% and specificity of 96.6% in the detection of malignant adnexal mases (26). Adnex MR scoring system (*Table 6*) may potentially influence pelvic mass management, inspired by the BIRADS classification this imaging scoring system accurately relays the radiologist's suspicions to the clinician. The combination or the morphologic and functional MR imaging features helps predict the final diagnosis. This scoring system would help to standardize MR imaging reporting with the aim of improving patient care (26,27). Criteria for considered predictive of benignity purely cystic lesions, a regular and homogeneous solid component with low signal intensity it T2W and solid component with a type 1-time signal intensity curve. The following criteria predictive of malignancy: vegetations, an irregular or heterogeneous solid component with high signal intensity on DW, a solid component with a type 3-time signal intensity curve or peritoneal implants or abdominal or pelvic ascites (*Tables 6-8*, *Figures 10-14*) (1,24,26,27,29,30).

O-RADS

This committee was created in order to standardize lexicon that would allow the development of a practical and uniform vocabulary to describe the imaging characteristics

Table 6 ADNEX MR scoring system (29)

1	No ovarian mass	No mass
2	Benign mass	Unilocular cystic mass of any type: no wall enhancement
		Unilocular simple cyst with no solid tissue with or without wall enhancement
		Endometroid or fatty masses without solid tissue with or without wall enhancement
		Cyst with solid tissue: homogeneous low signal on diffusion or T2W within solid tissue with mild or moderate enhancement (curves type 1 or 2)
3	Probably benign mass	Unilocular proteinaceous or hemorrhagic cyst with wall enhancement without solid tissue
		Multilocular cysts without solid tissue
		Cysts with solid tissue with intermediate T2 signal and type 1 enhancement curves
4	Indeterminate mass	Cysts with solid tissue, type 2 time signal intensity curve, intermediate T2 signal and high intensity on DWI
5	Probably malignant mass	Peritoneal implants or cysts with solid tissue with type 3 time signal intensity curve, intermediate T2 signal and high intensity in DWI

Table 7 ADNEx MR Lexicon (part 1) (24,27,30)

Finding	Description
Purely cystic mass	Unilocular cyst or hydrosalpinx, both of which have low T1-weighted and high T2-weighted MR signal intensities, and no internal enhancement
Purely endometriotic mass	Lesion displaying high T1-weighted signal intensity greater than or equal to that of subcutaneous fat, with shading on T2-weighted MR images and no internal enhancement
Purely fatty mass	Lesion displaying high T1-weighted signal intensity that disappeared after fat saturation and displaying no solid tissue
Wall enhancement	Wall enhancement of the wall of a cyst
Bi- or multilocularity	The presence of two or more septa in a cyst (a septum is defined as a thin strand of tissue running across the cyst cavity from one internal surface to the contralateral side)
Grouped septa	The presence of three or more septa close together in a part of the cyst; thickened regular septum or septa: a smooth septation with a thickness ≥3 mm within a cystic tissue
Solid tissue	As defined by the IOTA group, solid tissue shows flow at Doppler US flow. Thus, at MR imaging, solid tissue enhances after gadolinium chelate injection. In adnexal tumors, according to the IOTA group (13), diffuse wall thickening, normal ovarian stroma, and regular septa are not considered to represent solid tissue. Thus, solid tissue is either thickened irregular septa, and/or vegetation, and/or a solid portion (including completely solid mass)

Table 8 ADNEx MR Lexicon (part 2) (24,27,30)

Finding	Description
Purely cystic mass	Unilocular cyst or hydrosalpinx, both of which have low T1-weighted and high T2-weighted MR signal intensities, and no internal enhancement
Vegetations	Solid papillary projections, defined by the IOTA group as any solid projections into the cyst from the cyst wall with heights ≥3 mm
Solid portion	A solid nodule, as defined by the IOTA group. This group includes completely solid masses
Thickened irregular septa	Focal areas of septal thickening with thickness ≥3 mm within a cyst
T2-weighted signal intensity within solid tissue	Signal intensity defined in comparison with adjacent external myometrium (considered low if T2 signal is lower than and intermediate if T2 signal is equal to or higher than that of outer myometrium
b =1,000 s/mm^2—weighted signal intensity within solid tissue	Signal intensity defined in comparison with serous fluid (cystic bladder or cerebrospinal fluid) (considered high if b=1,000 s/mm^2 signal was higher than and low if b =1,000 s/mm^2 signal was equal to or lower than that of serous fluid)
Type 1 time—signal intensity curve within solid tissue	A gradual increase in the signal intensity of the solid tissue, without a well-defined "shoulder"
Type 2 time—signal intensity curve within solid tissue	A moderate initial increase in the signal intensity of solid tissue relative to that of myometrium
Type 3 time—signal intensity curve within solid tissue	An initial increase in the signal intensity of solid tissue that was steeper than that of myometrium.
Free fluid	Fluid in the peritoneal cavity
Peritoneal implants	Nodular thickening of the peritoneum that enhances after gadolinium chelate injection

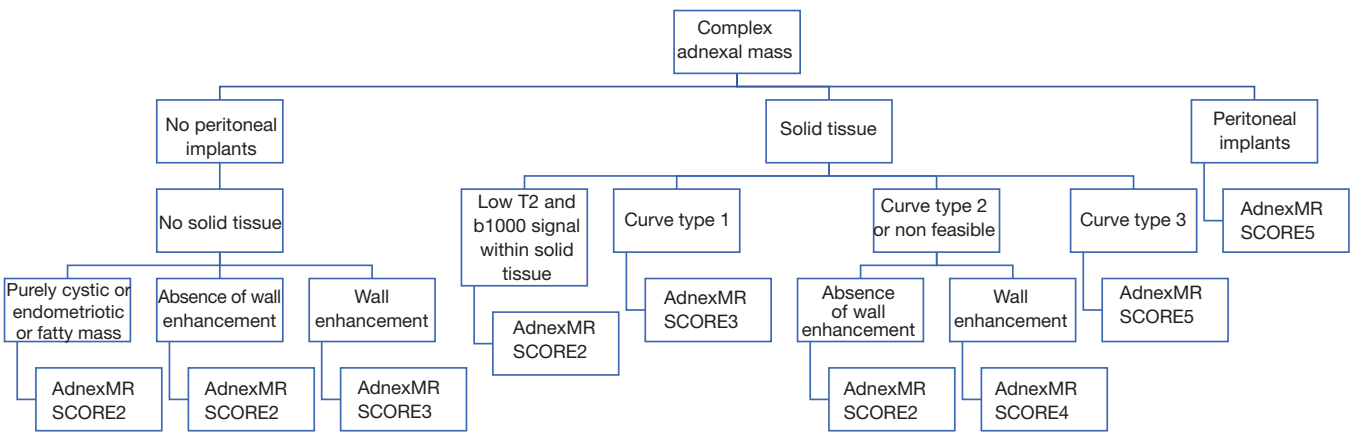


Figure 10 ADNEx MR Scoring System Flowchart showing recommendations for assessment adnexal masses.

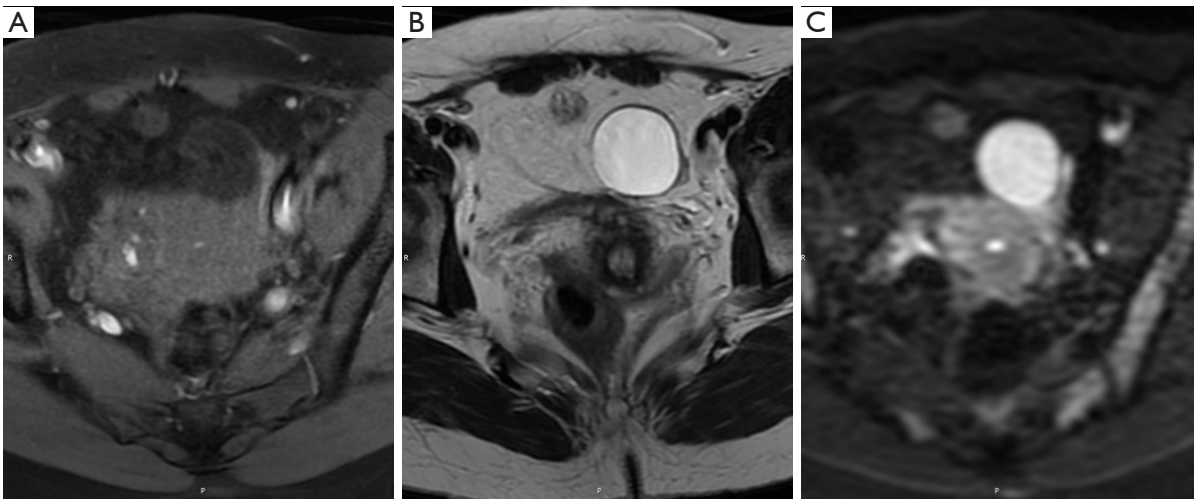


Figure 11 MRI of a female patient with a simple unilocular cyst ADNEx Score 2. (A) Axial T1W1 + C showing a low signal left ovarian mass; (B) axial T2WI MR demonstrates high intensity in the same mass; (C) axial DWI showing high intensity within the lesion.

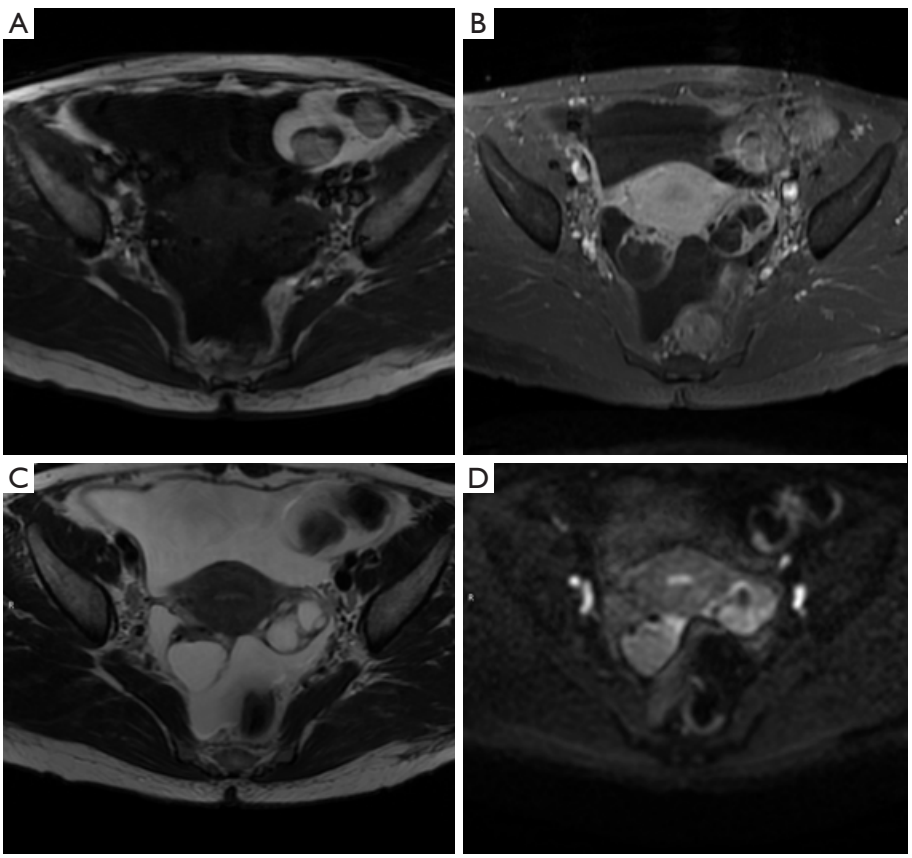


Figure 12 Multilocular cyst without solid tissue ADNEx Score 2. (A) Axial T1 shows bilateral adnexal well-defined masses with multiple locules; (B) T1WI + C show no enhancement in both lesions; (C) T2WI demonstrates both cysts with multiple high intensity lesions; (D) axial DWI shows high intensity in bilateral cysts.

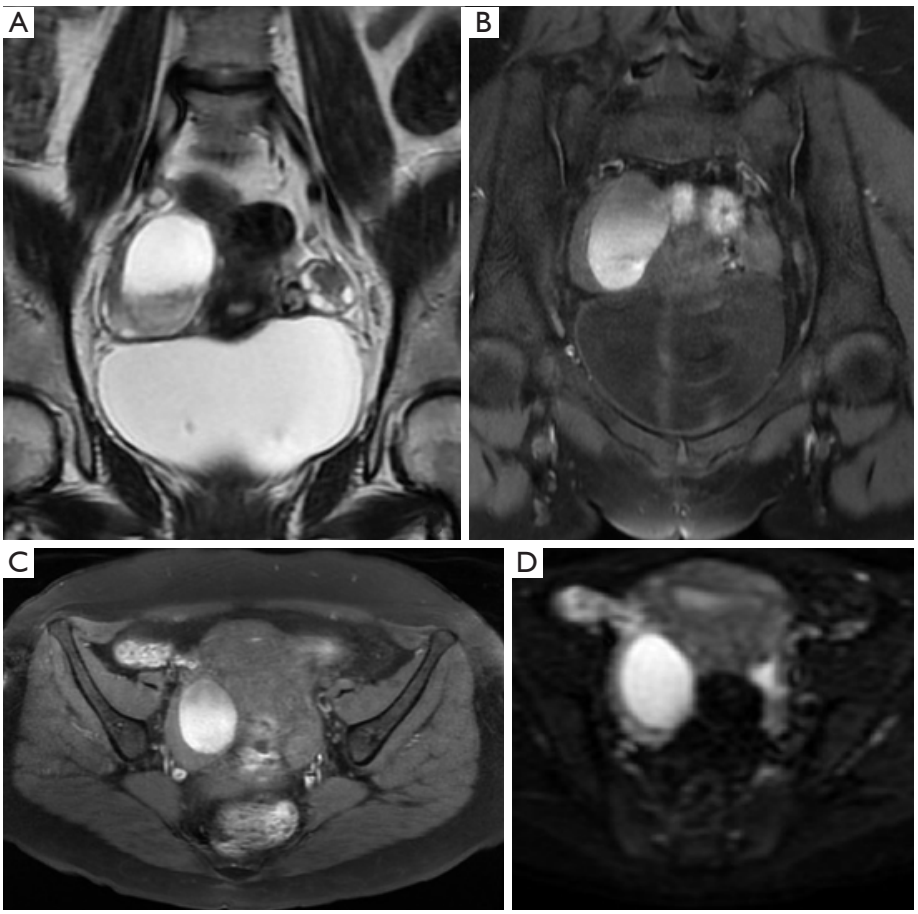


Figure 13 MRI of a female patient with a right hemorrhagic cyst. ADNEx Score 3 (A) coronal T2W1 showing a right adnexal cystic mass with hemorrhagic component and a fluid-fluid level (B). (C) Coronal and axial T1FS shows high signal intensity within the mass (D) DWI demonstrate high signal intensity (1,26).

of ovarian masses. From category O-RADS 3 low risk of malignancy (1% to <10%) needs a referral to ultrasound specialist or gynecologist with a view to MR and O-RADS 4 lesions with an intermediate risk of malignancy (10% to <50%) needs ultrasound specialist review or MR as well as management by a gynecologist. MR becomes a complement to the approach of patients with these categories (30).

CT and PET/CT imaging

Although the majority of incidental findings in computed tomography are benign there can be indeterminate or suspicious findings on. A CT examination (29,31).

Five percent of all CT scans may have adnexal cysts, which are mostly physiologic in premenopausal women or simple adnexal cysts in postmenopausal women.

The current American College of Radiology (8) Recommendations in regard to incidental adnexal findings represent a guideline that is based on the radiologist experience and the results of previous studies.

Boos *et al.* evaluated a prevalence of adnexal cysts initially detected at CT in 6.6% of the patients. Among all the patients, a 0.7% (18 cases) of a given diagnosis of ovarian cancer and 6.5% (7 cases) were large cysts. It is unlikely that simple cysts represent cancer and therefore imaging follow up criteria with other modalities besides ultrasound are not recommended.

A completely different scenario would be in hyperdense ovarian cysts as there are mucinous tumors and endometriomas that can manifest as hyperattenuating cysts. Therefore, follow-up imaging makes sense in agreement with the current ACR guidelines, no matter patient's age or

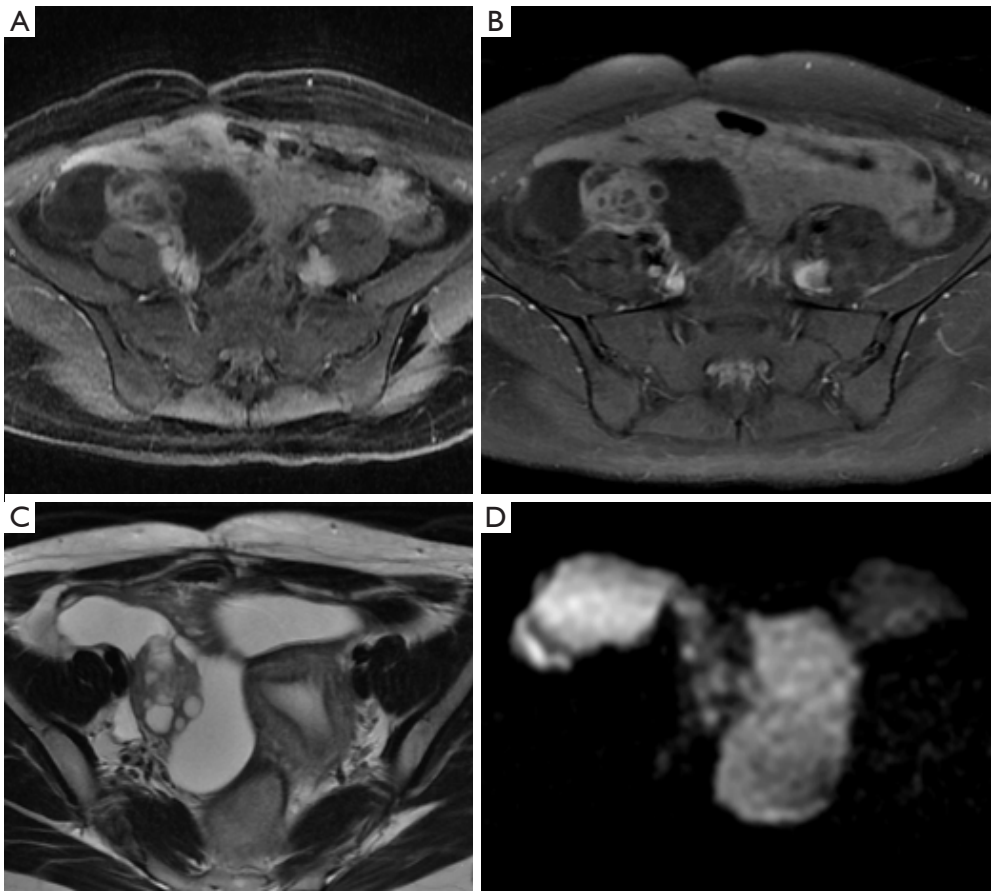


Figure 14 MRI of a female patient with a right multilocular cyst with solid tissue. ADNEx Score 4 (A) T1W1 showing a right adnexal cystic mass with a solid component; (B) T1WI FS shows no fat within the lesion; (C) T2W1 shows intermediate signal in solid tissue; (D) axial DWI demonstrates high signal in the right ovary.

menopausal status (32,33) (*Figure 15*).

PET/CT imaging with fluorine 18 fluorodeoxyglucose in the initial evaluation of patients with ovarian cancer is limited especially in those with early stage disease and in characterizing adnexal masses. Many ovarian lesions can have FDG uptake such as physiologic changes, teratomas, endometriomas, inflammatory masses, among others. FDG is mainly used as a staging tool and for the assessment of recurrent ovarian cancer (*Figure 16*).

Conclusions

The survival for a patient can be significantly improved with early detection. Ultrasound is a good low-cost imaging modality, of easy availability but can be subjective in comparison with other modalities. That is the reason why IOTA and O-RADS can help to improve that, as they are easy and reproducible classification systems with high sensibility and specificity for predicting ovarian malignancies. Other imaging modalities like CT imaging and PET/CT imaging remains as great imaging tools for cancer stratification. Cystic adnexal masses are a frequent incidental finding with a very low prevalence of malignancy. Hyperdense lesions should have follow-up images with adnexal ultrasound.

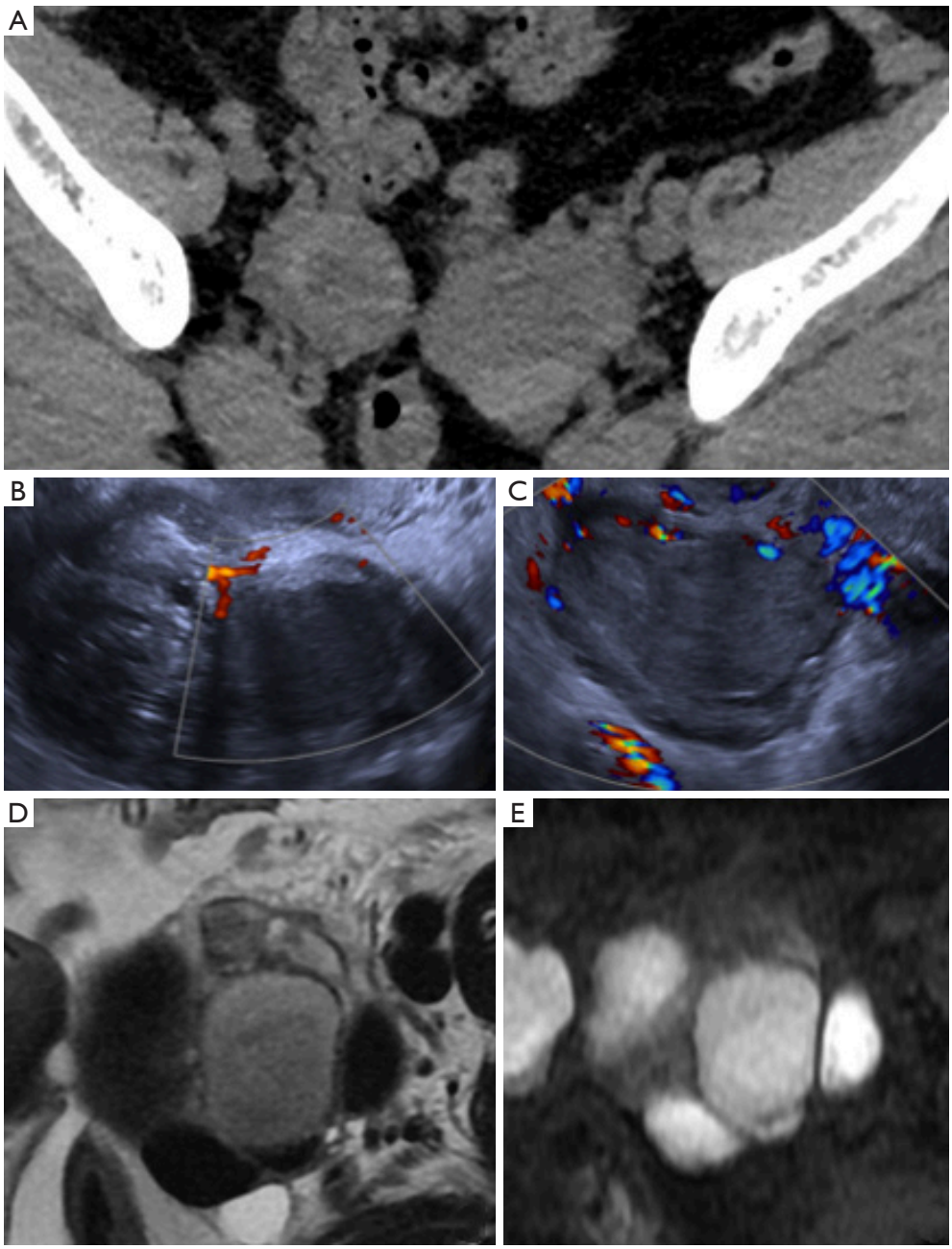


Figure 15 Incidental adnexal cyst (A) Simple CT showing hyperdense adnexal masses in both ovaries; (B,C) indeterminate adnexal mass in a transvaginal ultrasound with hypoechoic (B) and isoechoic components (C) with peripheral color scale 2–3. (D) T2 weighted MRI and (E) T1FS + C show a hyperintense in T1, hypointense T2 cysts consistent with endometriomas.

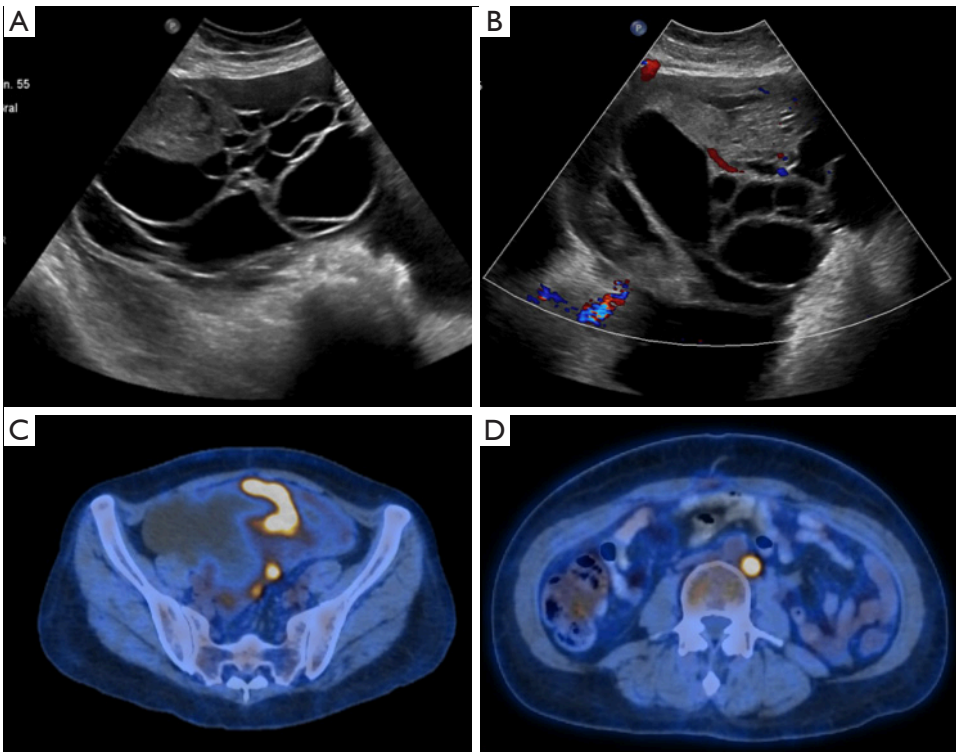


Figure 16 (A,B) Transabdominal ultrasound showing a multilocular ovarian cyst, >10 cm, with solid component and CS=2 at color Doppler. (C,D) PET/CT of the same ovarian lesion, showing hypermetabolism in the solid portions and a para-aortic adenopathy. Findings corresponding to a category O-RADS 4.

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