“COMPARISON STUDY OF MAGNETIC RESONANCE IMAGING AND ULTRASONOGRAPHY IN EVALUATION OF OVARIAN LESIONS WITH EMPHASIS ON OVARIAN ADNEXAL REPORTING AND DATA SYSTEM”

By

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Under the guidance of

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ABSTRACT

Introduction: Accurate characterization of ovarian lesions is crucial for appropriate clinical management, as it directly influences the decision between conservative follow-up, medical management, or surgical intervention. The Ovarian-Adnexal Reporting and Data System (O-RADS) has emerged as a standardized risk stratification system aimed at improving diagnostic accuracy and clinical management of ovarian-adnexal pathologies. This study was undertaken to compare the diagnostic performance of ultrasonography (USG) and magnetic resonance imaging (MRI) in the evaluation of ovarian lesions using the O-RADS classification system.

Materials and Methods: This prospective observational study was conducted in the Department of Radiodiagnosis at Shri B M Patil Medical College Hospital & Research Centre, Vijayapura from April 2023 to April 2025. A total of 44 patients with clinically suspected ovarian lesions who underwent both USG and MRI followed by histopathological confirmation were included. Lesions were characterized according to the O-RADS classification on both modalities, and the findings were correlated with histopathological results. “Statistical analysis was performed to determine sensitivity, specificity, positive predictive value, and negative predictive value of both imaging modalities.”

Results: The mean age of patients was 35.7 years, with the majority (65.9%) in the 21-40 years age group. Abdominal pain was the predominant clinical presentation (90.9%). Both USG and MRI showed identical morphological characterization of lesions, with multilocular cystic lesions without solid components being the most common (29.5%). The distribution of O-RADS scores was similar between both modalities, with most lesions classified as O-RADS 3 (61.4% on USG and 63.6% on MRI). Histopathologically, 79.5% of lesions were benign and 20.5% were malignant. A significant association was found between O-RADS scores and malignancy ($p<0.001$), with all O-RADS 3 lesions being benign and most O-RADS 5 lesions (80%) being malignant. Both USG and MRI demonstrated identical diagnostic performance with "100% sensitivity, 95% specificity, 98% positive predictive value, and 97% negative predictive value."

Conclusion: Both ultrasonography and magnetic resonance imaging, when utilized within the framework of the O-RADS classification system, provide excellent and comparable diagnostic accuracy in the evaluation of ovarian lesions. The significant association between O-RADS scores and histopathological outcomes validates the clinical utility of this classification system for risk stratification and management planning. A tiered imaging approach, with ultrasonography as the first-line modality

and MRI reserved for specific indications, appears to be the most rational and cost-effective strategy for evaluating ovarian lesions.

Keywords: Ovarian lesions, Magnetic Resonance Imaging, Ultrasonography, Ovarian-Adnexal Reporting and Data System, O-RADS, Diagnostic performance, Histopathology

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INTRODUCTION

Ovarian lesions represent a significant diagnostic challenge in gynaecological imaging, necessitating accurate characterization for appropriate clinical management and improved patient outcomes. The increasing incidence of ovarian pathologies, ranging from benign cysts to malignant neoplasms, has emphasized the critical need for precise imaging techniques to guide clinical decision-making.[1] In recent decades, both Magnetic Resonance Imaging (MRI) and Ultrasonography (US) have emerged as pivotal diagnostic tools in the evaluation of adnexal masses, each offering distinct advantages in lesion characterization.

Because of its accessibility, affordability, and absence of ionizing radiation, ultrasound especially transvaginal sonography, or TVS—has long been the main imaging modality used for the preliminary evaluation of ovarian abnormalities.[2] The real-time imaging capability of US, combined with colour Doppler assessment of vascularity, provides valuable information about lesion morphology and blood flow patterns. However, the technique's operator dependency and occasional limitations in tissue characterization have led to the exploration of complementary imaging modalities for enhanced diagnostic accuracy.[3]

Magnetic Resonance Imaging, with its superior soft-tissue contrast and multiplanar imaging capabilities, has revolutionized the evaluation of ovarian masses by offering detailed anatomical and pathological information. “The ability to characterize tissue composition through various pulse sequences, including T1-weighted, T2-weighted, and diffusion-weighted imaging, enables better differentiation between benign and malignant lesions”.[4] Furthermore, the addition of dynamic contrast-enhanced MRI provides crucial information about lesion vascularity and perfusion patterns, contributing to more accurate diagnosis and staging of ovarian malignancies.[5]

The introduction of standardized reporting systems has marked a significant advancement in gynaecological imaging. The “Ovarian-Adnexal Reporting and Data System (O-RADS)” represents a comprehensive approach to risk stratification of ovarian lesions using both ultrasound and MRI criteria.[6] This standardized lexicon and scoring system aims to reduce variability in interpretation and improve communication between radiologists and clinicians, ultimately leading to more consistent and appropriate patient management decisions.

Recent studies have demonstrated varying diagnostic accuracies between MRI and US in characterizing different types of ovarian lesions. While ultrasound excels in detecting and characterizing simple cysts and classic presentations of endometriomas, MRI offers superior capability in evaluating complex masses, particularly in cases where ultrasound findings are indeterminate.[7] The complementary nature of these imaging modalities suggests that their combined use may provide the most comprehensive assessment of ovarian pathology.

The economic implications of imaging selection cannot be overlooked in contemporary healthcare settings. While MRI offers superior tissue characterization, its higher cost and limited availability compared to ultrasound necessitate careful consideration of its role in the diagnostic algorithm.[8] Understanding the specific strengths and limitations of each modality is crucial for developing cost-effective imaging protocols without compromising diagnostic accuracy.

The accurate characterization of ovarian lesions has significant implications for patient management and surgical planning. Proper pre-operative assessment can help determine the necessity and extent of surgical intervention, potentially avoiding unnecessary procedures in cases of clearly

benign lesions.[9] Additionally, accurate imaging can guide the selection of appropriate surgical approaches, particularly in cases where fertility preservation is desired.

Recent technological advancements have further enhanced the capabilities of both imaging modalities. The development of 3D ultrasound and contrast-enhanced ultrasound has expanded the diagnostic potential of sonographic evaluation, while advanced MRI techniques, including perfusion imaging and texture analysis, have improved the ability to detect subtle tissue characteristics indicative of malignancy.[10]

This thesis aims to conduct a comprehensive comparison of MRI and ultrasonography in the evaluation of ovarian lesions, with particular emphasis on the application and utility of the O-RADS classification system. By analyzing the strengths and limitations of each modality across various pathological conditions, this study seeks to provide evidence-based recommendations for optimal imaging strategies in different clinical scenarios. The findings will contribute to the development of more efficient diagnostic algorithms and ultimately improve patient care in gynecologic oncology.

AIM & OBJECTIVES

- To evaluate ovarian lesions by ultrasonography and stratify them based on ovarian adnexal reporting and data system.
- To correlate findings of ultrasonography with M.R.I. and assess the accuracy of ovarian adnexal reporting and data system stratification by ultrasonography.

REVIEW OF LITERATURE

UTERINE ADNEXA

From the Latin word "adnectere," which meaning "to tie together" or "appendage," comes the word "adnexus."[12] “Adnexa (plural of adnexus) in radiography refers to the ovaries and the structures that surround them, such as the fallopian tubes, wide ligaments, and the surrounding arteries and nerves”.[13]

The following are included in the uterine adnexa:[14–16]

1. **The oviducts or fallopian tubes:**

- Stretch from the superior part of the uterus towards the ovaries; - Have two muscular tubes, one on each side of the uterus.

- Purpose: Facilitate fertilization by moving the ovum from the ovary to the uterus.

2. **Ovaries:** Two almond-shaped organs, one on each side of the uterus; connected to the wide ligament's posterior surface by the ovarian ligament; ova (eggs) produced; hormones secreted (progesterone and estrogen).

3. **Broad ligaments:** -nothing but Peritoneal folds stretches laterally from the uteru and contains ovaries, uterine tubes, blood vessels, nerves, and lymphatics.

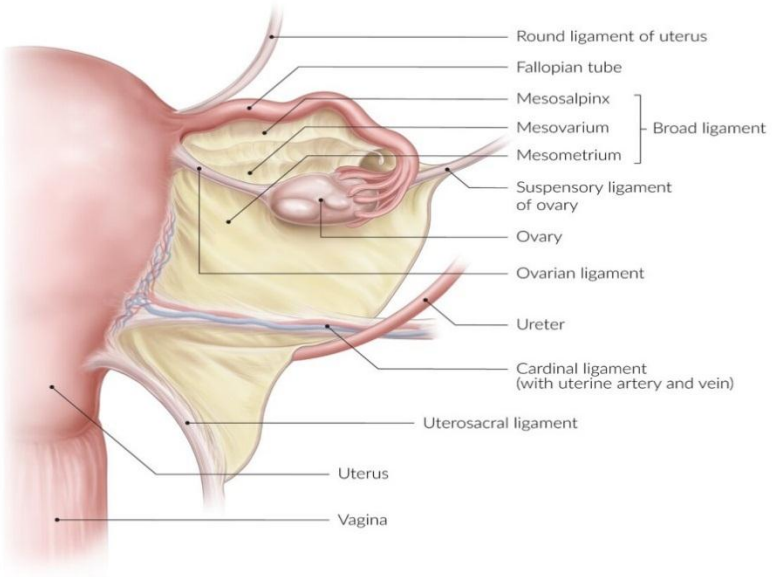
4. **Round ligaments:** These are fibromuscular bands that help keep the uterus in an anteflexed position by extending from the uterus via the inguinal canal.

5. **Ovarian ligaments:** The peritoneal folds, which connect the ovaries to the uterus, give the ovaries support and mobility.

6. **Suspensory ligaments:** The peritoneal folds, which connect the ovaries to the lateral pelvic walls, give the ovaries further support and placement.

In the female reproductive system, the uterine adnexa are essential for ovulation, fertilization, and hormone regulation. For optimal reproductive activity, they must maintain their natural anatomy and location.

Figure 1: Uterine Appendages



ADNEXAL MASSES

Definition:

Adnexal masses are tumor masses that arise from the fallopian tubes, ovaries, and tissues surrounding these organs.[1]

Adnexal masses are a frequent gynecologic issue that are among the most often seen disorders in the outpatient clinic. They can affect women at any stage of life, from fetuses to elderly individuals, and their prevalence and origin vary correspondingly. Adnexal masses can result from endometriosis, inflammatory processes, malignant and benign tumors, or functional or physiological alterations. The uterus, colon, retroperitoneum, or metastasizing disease from another site, including the breast or gastrointestinal system, can also cause pathology in this region. Thus, it is necessary to differentiate the differential diagnosis from a non-gynecologic illness.[1]

They present a diagnostic challenge because to the difficulty of diagnosis and the wide range of benign, malignant, and borderline illnesses included in differential diagnosis. The main factors influencing the risk of malignancy include age, menopausal state, symptoms, imaging characteristics, and tumor markers.[17]

Burden Of Diseases

Since the majority of adnexal masses are asymptomatic and go undetected, it is unknown how common these masses actually are in the general population. are typically found through physical examination or screening with pelvic imaging. Adenoidal masses less frequently exhibit intermittent or intense pain sensations.[1] According to estimates, the prevalence of ovarian tumors that are likely benign is from 14% to 18% in postmenopausal women and from 7% to 18% in women who are fertile. Adnexal masses that are malignant or borderline tumors make up about 2% of the total.[2]

Over the past three decades, ovarian cancer's incidence and mortality have remained consistent. It is currently the fifth most prevalent cause of cancer-related fatalities for women in developed nations and the primary cause of death from malignant neoplasms of the female genital tract.[18, 19] Of all the gynecological cancers, malignant epithelial ovarian tumors are linked to the greatest fatality rate. As little as 10% of ovarian malignancies survive for five years after diagnosis when they are in advanced stages. An up to 90% 5-year survival rate is possible with early diagnosis.[20]

NEED FOR RISK STRATIFICATION

For the best possible patient care, ovarian and other adnexal masses must be accurately characterized. Lesions that are probably benign should be managed more conservatively and gently. However, patients should be sent to a gynecologic- oncologist when cancer is suspected, as this is known to improve the prognosis.[21–23] The ultimate objective is to minimize needless surgical procedures in patients with minimal risk of malignancy while optimizing ovarian cancer

outcomes. For patients with little risk of cancer, consideration should be paid to avoiding surgical morbidity and maintaining hormonal competency.

A global panel of specialists, spanning multiple disciplines, was assembled to conduct a comprehensive analysis of the current state of research on asymptomatic adnexal masses and develop guidelines for clinical evaluation and treatment. “These suggestions were intended to optimize referrals to gynecologic oncologists in situations of suspected ovarian cancers and to encourage more conservative care for benign illness. In the United States, it is predicted that 200,000[24, 25] women have surgery for a pelvic tumor, but only 21,2903 of those women are ultimately diagnosed with ovarian cancer. Additionally, we observe that, in contrast to the European International Ovarian Tumor Analysis (IOTA) center trials, there are roughly 9.1 surgeries per malignancy[24] in the United States, with only 2.3 (oncology centers) and 5.9 (other centers) reporting surgeries per malignancy. This suggests that we can still make improvements to our preoperative assessments. The majority of pelvic masses in postmenopausal women will require surgical intervention, with the exception of small cysts on a transvaginal ultrasound finding, according to the American College of Obstetricians and Gynecologists Practice Bulletin on "Management of Adnexal Masses," which was reaffirmed in 2015. There is a chance that surgically removing benign lesions will result in complications; they can range from 2% to 15%.[26] When a gynecologic oncologist performs surgery and treatment for a suspected cancer, survival rates are increased.[27] Remarkably, only 33% of ovarian cancer patients benefit from a preoperative referral to a gynecologic oncologist; [28] as a result, treatment results can be enhanced by making greater use of gynecologic oncology. While skilled sonographic adnexal examination can accurately define the majority of benign or malignant adnexal masses,[29] the committee acknowledged that sonography is frequently performed and evaluated by practitioners with varied degrees of expertise. With the introduction of alternatives, like as evidence-based risk-assessment algorithms and referrals to gynecologic-oncologists or "expert sonologists," this acknowledgment offered a chance to enhance risk stratification. The panel felt that by working to enhance clinical risk assessment and triage procedures, patient care would eventually improve”.

HOW TO DIFFERENTIATE BETWEEN BENIGN FROM MALIGNANT.?

To evaluate an adnexal tumor, the malignancy risk index must be estimated. The definition that takes into account the features of the image along with age, personal and family history of cancer, symptoms, physical examination results, and tumor marker levels.[18] As a result, patients are categorized as having a high or low risk of cancer (Table 1). Particular focus should be placed on risk or protective factors for ovarian cancer as indicated by symptoms indicative of the disease in the medical history, as well as a family history of ovarian, colon, or breast cancer.[30, 31] "A thorough physical examination is helpful in characterizing the patient. This includes determining the patient's performance status, body mass index, palpable peripheric lymph nodes, and degree of leg lymphedema".

The most significant indicators of malignancy suspicion are found in the clinical scan of the abdomen, which includes ascites, a palpable mass in the abdomen, mobility, and anatomic relationships with the uterus, bladder, and rectum-sigmoid assessed by vaginal examination.[30] Laboratory and imaging studies can shed light on a pelvic mass's possible cause. For women who are of reproductive age, pregnancy testing is required.[1]

Table 1: "Risk Stratification for Adnexal Masses"

"Characteristic	High- Risk	Low-Risk
Age	> 50 yrs	< 50 yrs
Family history	Yes	NO
Symptoms	Present	Absent
Tumor markers	Raised	Normal range
USG finding	≥ 10 cm, multilocular thick septations, papillary projections present	< 10 cm, absent or thin septations (1–2 mm), unilocular, absent papillary projections"

Age

“In the general population, age is a substantial independent risk factor for ovarian cancer, and the incidence rises dramatically with the start of menopause. Ovarian cancer is generally uncommon before the age of 50, but its occurrence rises noticeably with age”.[18] Compared to premenopausal women, postmenopausal women have an increased risk of cancer. Nonetheless, benign neoplasms like cystadenomas account for the majority of adnexal masses in postmenopausal women. Most simple and hemorrhagic cysts in women who are fertile are caused by physiological processes. Simple cysts are also prevalent and clinically insignificant in postmenopausal women.[32] When a postmenopausal woman experiences vague symptoms in the past year, such as increased abdominal volume, unexplained weight loss, irritable bowel syndrome, or unclear gastric symptoms, appropriate tests should be performed to rule out ovarian cancer. “This is especially true for women who are over 50 or who have a strong family history of breast, ovarian, or colon cancer”.[30]

“Personal And Family Background

Nulliparity, endometriosis, early menarche, late menopause, Caucasian race, and primary infertility are risk factors for ovarian cancer.One However, a strong personal or family history of breast or ovarian cancer continues to be the most significant personal risk factor for ovarian cancer because they may have damaging mutations in genes associated to these two types of cancer.The majority of gynecological malignancies occur randomly, while 10-15% of OC have a genetic pattern linked to BRCA gene abnormalities.[33] A lifetime risk of 39–46% and 11–27%, respectively, for developing OC is associated with BRCA1 and BRCA2 mutations.[34] In addition to BRCA1 and BRCA2, other genes are linked to ovarian cancer.35 Women with Lynch syndrome are thought to have a 5–10% chance of developing ovarian cancer up until the age of 70.[1] A geneticist should be consulted if there is a high chance of inherited ovarian-breast cancer predisposition based on personal or family history”.

Symptoms and Physical Examination

A greater risk of cancer exists in patients with symptomatic adnexal masses, particularly climacteric ones.[18] Over the past year, nonspecific symptoms of ovarian cancer have included lethargy, unexplained weight loss, vague stomach issues, and irritable bowel syndrome. More particular, signs of infiltrative or compressive behavior are recognized when abdominal volume is increased, resulting in pelvic pain, altered bowel habits, irregular uterine bleeding, and a fullness sensation in the bladder. These symptoms are recent, rapid to manifest, and long-lasting.[35, 36] The physical examination can offer certain criteria for differentiating between benign and malignant lesions, despite its low sensitivity in identifying adnexal masse.

Tumour Markers

Tumour markers are useful for the differential diagnosis of adnexal masses either by themselves or in conjunction with imaging tests and clinical data. Testing for serum markers can help determine whether surgery is necessary and how likely a cancer is.[1]

In 80% of ovarian carcinomas, the transmembrane glycoprotein CA125 is increased, particularly in advanced tumors.[37] The most common tumor marker for distinguishing between benign and malignant adnexal tumors is this one. The range of 61% to 90% is the sensitivity rate of CA125 in identifying benign from malignant diseases. “The range of specificity rates is 71% to 93%. The range of the positive and negative predictive values, respectively, is 35% to 91% and 67% to 90%.[38] Less than half of women who have had first ovarian cancer have elevated CA125 levels. Women who have benign premenopausal disorders, such as endometriosis, physiological abnormalities, pregnancy, and menstruation, may also have elevated CA125 levels.[39] The malignancy of an adnexal tumor cannot be diagnosed only by looking at CA125 values. Because the test is generic, an average rate does not rule out ovarian cancer even though a very high score can help in the diagnosis”.[30]

“When an ultrasound diagnosis of a simple ovarian cyst has been obtained, not all premenopausal women need to undergo a serum CA-125 assay. It is advised to

speak with a gynecologic oncologist if the serum CA-125 test results are greater than 200 units/ml".[31]

"Human epididymis protein 4, or HE4, is a protein involved in sperm maturation that has been utilized to differentiate between adnexal tumors and certain types of ovarian cancers.[40] The presence of malignant neoplasms is not the only factor that affects serum HE4 concentrations. This marker is helpful in the following circumstances: variations happen with age, smoking, and chronic renal disease, but not with the menstrual cycle, contraception, or endometriosis.[41] All women under 40 with a complicated ovarian mass should have measurements of lactate dehydrogenase (LDH), α-fetoprotein (α-FP), and human chorionic gonadotropin (hCG) due to the potential for germ cell cancers".[31]

Imaging

- **Ultrasonography**

Ultrasonography is now regarded as the "preferred method in the initial investigation of adnexal masses, particularly when employing transvaginal ultrasound", despite the lack of a universal screening program for ovarian cancer.[3] Its benefits include being a safe method that spares the patient from radiation exposure, being more economically accessible than other imaging modalities like computed tomography (CT) and magnetic resonance imaging (MRI), and being accessible to a large number of radiologists and gynecologists across the globe. Additionally, the examiner can employ the transvaginal ultrasound transducer as an adjunct to the gynecologic examination, which can assist in connecting the patient's complaints to the precise anatomic site on ultrasound. "In order to evaluate the vascularity of tissue and maybe aid in the characterization of certain adnexal masses, color and pulsed Doppler imaging can be incorporated".[4]

"It can be difficult to classify adnexal masses as benign or malignant using ultrasonography because there is a lot of subjectivity involved and the sonographer's experience matters". The ultrasonic equipment that is used and its adjustments are also crucial. The International Ovarian Tumor Analysis (IOTA)

group established criteria and terminology in 2000 to aid with this effort and explain tumor traits that should be assessed by ultrasonography.[5]

The sonographer's subjective assessment, which is entirely reliant on the examiner's experience and training, offers the highest diagnostic validity when it comes to characterizing adnexal masses.[6, 7] However, a non-expert sonographer typically has their initial interaction with the patient. Various ultrasound ratings have been presented in an effort to replace the expert's experience as much as feasible and make the classification of these lesions more objective.

“Thickness (>2–3 mm) and irregularity of walls and septa, solid portions and papillary projections, along with other signs of malignant activity such as ascites, peritoneal nodules, and metastatic lesions are morphological traits suggestive of malignancy. In terms of vascularization, a color Doppler scan can show the location and presence of new tumor blood vessels. A peripheral blood flow is more indicative of a benign lesion, whereas a primarily central blood flow is more frequently linked to malignancy.[42] Doppler ultrasound has demonstrated a sensitivity of 84% and a specificity of 82% in the diagnosis of cancer in an ultrasound-indeterminate adnexal tumor”.[10]

- **Computed tomography**

After contrast is administered, computed tomography (CT) scans of the abdomen and pelvis are useful for assessing the spread of malignant lesions and identifying recurrences following therapy. However, CT scans for the primary detection and characterisation of ovarian masses are not as useful. Only lesions with calcifications and fat tissue, such as mature teratomas, can be easily recognized with CT scans. When diagnosing ovarian cancer from an adnexal tumor that is sonographically ambiguous, “CT has demonstrated a sensitivity of 81% and a specificity of 87%. The preferred imaging modality for staging is computed tomography (CT); it is crucial to detect ascites, lymphadenopathy, and omental and peritoneal implants in order to determine the extent of the disease.[10] By comparing pre- and post-treatment CT scans, therapy response evaluation is typically carried

out (ideally after six cycles of chemotherapy). If serum indicators are negative or their levels are not declining, a three-cycle chemotherapy regimen with a one-month interval between CT scans is recommended".[43]

- **^{18}F-FDG PET/CT**

Its application is growing, and it seems to "play a critical role in the assessment of ovarian tumors and the postoperative monitoring of patients who have a suspicion of recurrence.[10, 44] This imaging technique serves a critical role, particularly when CT scans are negative but serum marker levels rise. It has showed a sensitivity of up to 91% and a specificity of up to 100% in the identification of cancer recurrence.[43] Since PET/CT can produce false-positive and false-negative results, it is typically not used in the initial evaluation of these patients. It must be remembered that while small (<1 cm)", necrotic, and low-grade tumors may not exhibit FDG uptake, a number of benign lesions, including teratomas and endometriomas, may.[45] Nonetheless, it has always been abnormal to encounter postmenopausal individuals with elevated FDG uptake.

- **MRI**

When determining the origin of a pelvic mass and subsequently characterizing an adnexal mass, magnetic resonance imaging (MRI) is a crucial diagnostic tool, particularly for individuals with ambiguous lesions.[46] Local invasion detection with MRI is also dependable. The primary benefits of MRI are its high contrast resolution, which allows for great contrast between soft tissues, and its non-ionizing radiation exposure—a factor that is especially crucial for young female patients.

Both T1- and T2-weighted sequences are required to investigate the morphological and signal intensity properties of the mass as well as to gather anatomical information. Fat tissue and areas with hemorrhagic areas can be identified using fat-saturated T1-weighted images. Intravenous gadolinium enhances the ability to detect implants in the peritoneum and omental region, as well as enhancing septa and solid components inside the mass.

“Unenhanced MRI has demonstrated a sensitivity and specificity of 76% and 97%, respectively, in the diagnosis of ovarian cancer in the evaluation of adnexal masses ambiguous on ultrasound; assessment with contrast-enhanced MRI enhances sensitivity to 81% and specificity to 98%”.[10]

“Diffusion-weighted imaging (DWI) is a potentially helpful method for evaluating adnexal masses, however there has been debate in the literature over its application. DWI "is not useful" and "provides no additional information" in differentiating benign from malignant ovarian tumors, according to Katayama et al.[47] and Fujii et al.,[48] Diffusion-weighted and T2-weighted images can be used to predict whether a lesion is benign or malignant (Thomassin-Naggara et al., 2009). Lesions with high signal intensity on DWI and intermediate signal on T2-weighted images were more likely to be malignant, while masses with low signal intensity on both sequences were more likely to be benign.[49] More recent research[50] has demonstrated that high signal intensity on DWI is more common in malignant lesions and can help distinguish them from benign ones. It should be noted that a number of benign lesions, including as fibrothecomas, teratomas, and endometriomas, may also exhibit restricted diffusion. Nevertheless, T1-weighted, T1-weighted fat-suppressed, and T2-weighted standard sequences can typically be used to confidently diagnose these lesions.[51] In a 2010 study, Kyriazi et al. examined the use of DWI in the imaging of peritoneal carcinomatosis in patients with advanced ovarian cancer, demonstrating its potential utility for recurrence monitoring and for determining the volume and location of disease sites.[52] DWI is helpful in differentiating between borderline and malignant epithelial ovarian tumors, as Zhao et al. (2014) showed.[53] Diffusion-weighted pictures should therefore be a part of the MRI protocol”.

“While the utility of 1.5 T MRI in the evaluation of ovarian tumors is well known, the use of 3 T MR systems in the investigation of gynecologic disorders is relatively new”.

“Regarding magnetic field strength, the primary benefit of 3 T MR systems is the anticipated two-fold increase in MR signal-to-noise ratio (SNR) over conventional 1.5 T MR scanners; this SNR gain can be utilized to enhance speed, spatial resolution, or both. However, to preserve the necessary image contrast, the pulse

sequence parameters at 3 T must be reoptimized from 1.5 T values. At 3 T, it may be more visible and difficult to suppress image artifacts caused by changes in tissue susceptibility, chemical shift, radiofrequency effects, and/or pulse sequence physics. DWI sequences in particular may have enhanced susceptibility artifacts and warping at 3 T.[54] Qualitative assessment and quantitative analysis can be troublesome because prior research[55] has demonstrated that pictures suffer from considerable distortions and signal losses when body DWMRI techniques are shifted from 1.5 to 3 T without further changes. As a result, protocol modification at 3 T is required because poor image quality could have detrimental effects on diagnosis".

One non-invasive diagnostic technique that could help with the differential diagnosis of ovarian tumor subtypes is proton magnetic resonance spectroscopy. High quality MR spectroscopy is made possible by 3 T systems' enhanced signal-to-noise ratio and greater spectrum separation, which are added benefits to the 1.5 T system. When separating mucinous from nonmucinous ovarian tumors, proton MR spectroscopy can be used to detect the presence of mucinous material containing N-acetyl mucinous chemicals. As a result, MR spectroscopy aids in the diagnosis of ovarian tumor subtypes and may assist ensure that patients receive the right care, enhancing patient management.[56]

Multimodal tests

Research has examined the efficacy of utilizing biomarker panels in conjunction with clinical and radiologic assessment to differentiate between benign and malignant adnexal tumors. Serum biomarker panels may be used in place of the CA 125 level alone in cases of adnexal mass surgery to determine whether or not gynecologic oncology referrals are necessary. These biomarker panels can assist in identifying the patient who would benefit from a referral to gynecologic oncology, even though they shouldn't be employed in the first assessment of adnexal masses.[1] There isn't enough data available at this time to support the recommendation of a certain test.

"The menopausal status, ultrasonography results, and serum levels of CA 125 are combined into the risk of malignancy index (RMI) algorithm. It is computed using

the following formula and used to evaluate the risk of cancer. RMI = U x M x CA 125 (where U is the score, M is the menopausal status, and CA 125 is the serum level).[57] The method's sensitivity and specificity are 85% and 97%, respectively, when the RMI 200 limit is used. Individuals with an RMI of 0.15 had a 42-fold lower risk of cancer than those with a value of more than 200. The most effective diagnostic tool for women with suspected ovarian cancer is the RMI, according to a systematic evaluation of diagnostic studies".[31]

"The ROMA (Risk of Ovarian Malignancy Algorithm) algorithm, a quantitative test that combines the concentration of CA 125, HE4, and menopausal state, is the most common way that HE4 is used to determine the risk of malignancy.[58] The test is computed for perimenopausal and postmenopausal women using distinct logistic regression formulae that take into account the logarithm of CA 125 and HE4 concentration. None of these tests—CA 125, HE4 on its own, RMI, and ROMA—has the specificity to definitively distinguish benign from malignant adnexal tumors. Nonetheless, they are helpful in determining the risk and, in conjunction with clinical and imaging data, whether the patient can receive expectant care, investigate at general hospitals, or be referred to oncologic centres in light of the high risk of malignant neoplasm. Since endometriosis does not cause significant changes in HE4, it can be used to distinguish between adnexal masses that are symptomatic of the disease and those that have elevated CA 125".[59]

SCORING SYSTEMS FOR RISK STRATIFICATION OF ADNEXAL TUMORS

A three-step method has been suggested by the IOTA group to enhance the assessment of adnexal mass. Using Simple Descriptors through pattern recognition is the first stage. The IOTA Simples Rules are the second step, and an expert radiologist's subjective evaluation is the third. It has been demonstrated that this approach offers the best specificity and sensibility for classifying adnexal masses.[60]

Figure 2: Evolution of Adnexal Mass Classification System Thought 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)

IOTA “Simple Descriptors”

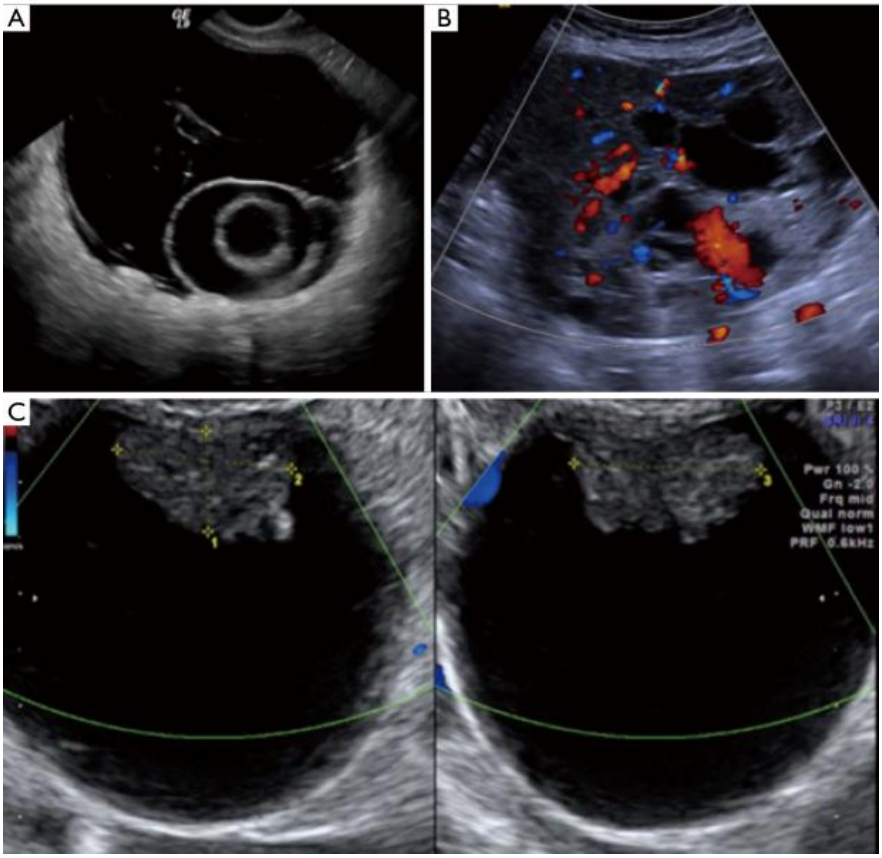
“Alternatively referred to as "easy instant diagnosis," these tests comprise six distinct ultrasonographic patterns that correlate to particular adnexal diseases and blood CA-125 readings in patients 50 years of age or older”.[60]

Figure 3: IOTA Simple Discriptors

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

The mass is regarded as "non-classifiable" or "non-instant" if none of them apply. would prompt the following action: IOTA Basic Guidelines.[61]

Figure 4: “Two patients' transvaginal adnexal ultrasounds, categorised using International Ovarian Tumour Analysis (IOTA) criteria (A) Multilocular tumour of the left ovary, less than 10 cm in diameter. Benign characteristics: (B) a highly vascularised ovarian tumour with a solid and cystic adnexal mass. (C) A cystic lesion with a solid papillary projection larger than 7 mm is a malignant characteristic. unidentified lesion”.



IOTA “Simple Rules”

In an attempt to distinguish between benign and malignant adnexal tumors, the IOTA group published ten rules (IOTA Simple Rules, SR) in 2008. These guidelines were based on the descriptions provided by Timmerman et al.[62] Ten ultrasonography features are included in an attempt to distinguish between benign

and malignant adnexal lesions. These five descriptors indicate five characteristics that are benign (B features) and five characteristics that are malignant (M features). “Three hypotheses were examined in a cancer investigation, according to SR. (A mass is classified as malignant if it displays one or more characteristics of malignancy and neither benignity nor malignancy is present; it is classified as benign if it displays one or more characteristics of benignity and neither malignancy nor benignity is present; if neither abnormality nor benignity characteristics are evident, the mass is classified as "inconclusive")”.

“When used by novice sonographers, the Simple Rules have a sensitivity of 91–96% and a specificity of 68–93%,[63] correctly detecting 75% of adnexal masses. Since 40% of inconclusive instances turn out to be malignant in the end, the third step for the left 25% of inconclusive lesions is to submit the case to a gynecological oncologist or an experienced sonographer”.[62]

The IOTA group released the "Simple Rules-Risk Assessment" in 2016.[64] The following characteristics are classified as benignity features (B features):

Table 2: IOTA Simple Rule Risk Assessment

B features	**M features**
Unilocular (B1)	Irregular solid tumor (M1)
Presence of a solid component with a maximum diameter of less than 7 mm (B2)	Ascites (M2)
Acoustic shadows (B3)	4 papillae (M3)
Regular multilocular tumor with a maximum diameter less than 100 mm (B4)	Multilocular irregular solid tumor with maximum diameter > 100 mm (M4)
Negative color map(B5)	Plentiful color map (Score color 4) (M5)

“The ADNEXA model, which stands for Assessment of Different Neoplasias in Adnexa, was released in 2014.[65] Six ultrasound values, one biochemical parameter (serum CA125, expressed in IU/mL), the patient's age (years), the kind of center (a tertiary referral center with a dedicated oncology unit vs. a non-oncology center) are used in this prediction model. The findings are expressed as percentages of the lesion's risk of being benign, malignant, or borderline. One benefit of the ADNEX model is that it offers the likelihood of cancer at each stage (stage I, II–IV, and ovarian metastasis).[66, 67] Take note that CA125 would enhance the ability to distinguish ovarian cancer in stages I through IV”.

The best method for evaluating adnexal masses before surgery is magnetic resonance imaging (MR). The MR scoring method was released in 2013 by Thomassin-Naggara et al. and has a sensitivity of 93.5% and a specificity of 96.6% for the identification of malignant adnexal mases.[11] The BIRADS categorization served as inspiration for the Adnex MR scoring system, an imaging scoring system that effectively communicates the radiologist's suspicions to the physician and may have an impact on pelvic mass care. The ultimate diagnosis can be predicted with the help of the combination of morphologic and functional MR imaging data. “To improve patient care, this rating system would aid in standardizing MR imaging reports.[11, 68] The only conditions that are thought to be predictive of benignity are cystic lesions, a regular and homogeneous solid component with low signal intensity on T2W, and a solid component with a type 1-time signal intensity curve. Among the features that are suggestive of malignancy include peritoneal implants, vegetation, an irregular or heterogeneous solid component with high signal intensity on DW, a solid component with a type 3-time signal intensity curve, and abdominal or pelvic ascites”.

Figure 5: Adnexa Scoring System

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

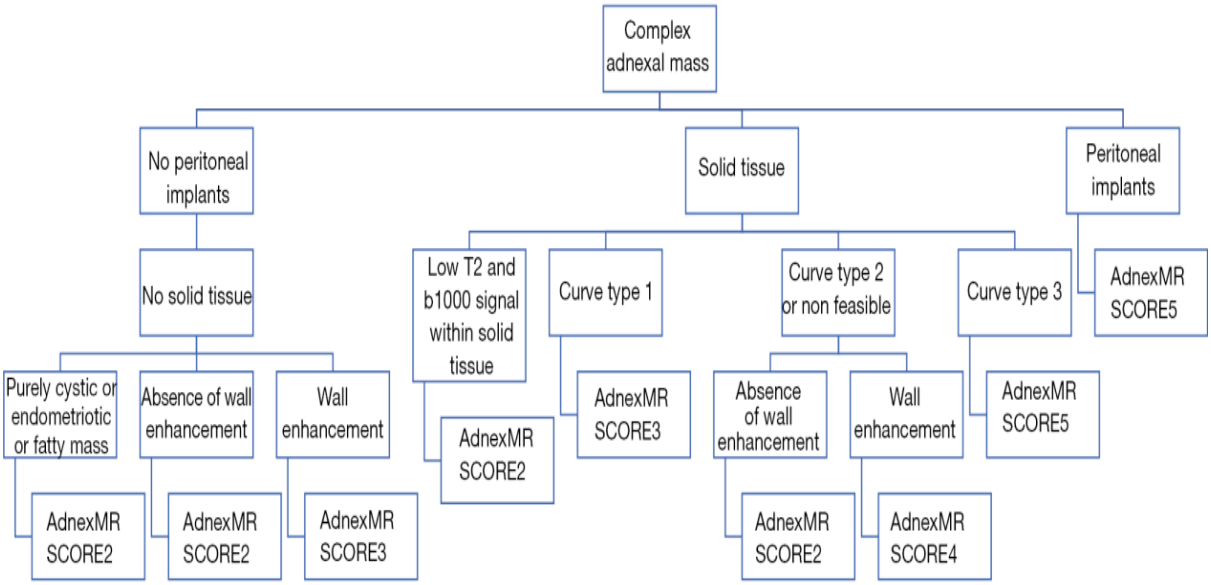
Figure 6: Adnexa MR Lexicon(Part 1)

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)

Figure 7: Adnexa MR Lexicon(Part 2)

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 8:"Adnexa MR Scoring System Flowchart Showing Recommendations for Assessment Adnexal Masses".



However, the classification of ultrasound risk remains problematic. “In 2018, the American College of Radiology (ACR) and IOTA created a white paper discussing the Ovarian-Adnexal Report Data System (O-RADS) for categorising adnexal masses. O-RADS” aims to offer a standardised vocabulary that encompasses all relevant descriptions and definitions of the distinctive sonographic features of healthy ovaries as well as ovarian or other adnexal abnormalities.66

The Ovarian-Adnexal Reporting and Data System (O-RADS) was released in 2020, and the American College of Radiology (ACR) specified the language characterizing adnexal lesions based on IOTA descriptions in 2018. Adnexal masses are categorized into six groups, and each category has its own set of care guidelines and probabilities related to the likelihood of malignancy.[69, 70] “O-RADS 0 denotes an incomplete evaluation; O-RADS 1 is used for physiological cysts or normal ovaries with a 0% probability of malignancy; O-RADS 2 (<1% malignancy) is set for a lesion that is most likely benign; For lesions with a low risk of cancer, O-RADS 3 is employed.(1-49%); A lesion with an O-RADS score of 4 indicates an intermediate risk of malignancy. (10–49%), and O-RADS 5 is associated with a higher risk of cancer (≥50%)”.[71]

O-RDS MRI SCORE FOR RISK STRATIFICATION

“The Ovarian-Adnexal Reporting and Data System (O-RADS) MRI committee of the American College of Radiology (ACR) has released a risk assessment system and lexicon for adnexal lesions.[8, 72] A broad multidisciplinary team of worldwide authorities in adnexal imaging and management from the radiology and gynecology domains participated in this endeavor. While the O-RADS MRI risk stratification system offers a data-driven method for determining the possibility of malignancy, the ACR O-RADS MRI lexicon has standardized words and definitions for evaluating and reporting adnexal lesions.[8, 73] Increasing reproducible communications between radiologists and referring physicians is the main objective of the O-RADS MRI risk stratification system. This will help women with benign lesions or borderline tumors avoid needless or excessive surgery, while women with potential malignancies will be quickly referred for oncologic surgical evaluation. As the radiology community has discovered throughout decades of use with the ACR Breast Imaging Reporting and Data System, a

codified system substantially facilitates both consistent instructional products and impactful multi-institutional outcomes research. This makes codified systems an important secondary goal".

"ACR O-RADS MRI STRATIFICATION SYSTEM: DEVELOPMENT AND METHODOLOGY

The previously created ADNEX MR scoring system serves as the foundation for the O-RADS MRI stratification system.[11] The ADNEX MR scoring system was created using an algorithmic methodology that takes into account the features of lesions that professionals use to determine risk. This involves evaluating the solid components (solid tissue, clot, debris, fat) and the fluid components (simple, hemorrhagic, proteinaceous, endometriotic, lipid). Any solid tissue enhancement is significant because it raises the probability of a neoplastic lesion; also, the kinetics of enhancement aid in the classification of the lesion as having a low, intermediate, or high risk of becoming malignant. Anatomic and functional MRI data are combined in the ADNEX MR scoring system, which then assigns a numerical score and PPV for malignancy.[11, 74] The O-RADS MRI risk stratification approach was modeled after the earlier ADNEX MR 5-point scoring system, which has been externally validated by multiple parties".[75, 76]

Every O-RADS MRI risk score has a cancer prognostic value (PPV), which is based on a "prospective, multicenter, extensive cohort study by Thomassin-Naggara et al.[11] The study involved the assignment of an O-RADS MRI risk score by two radiologists to lesions in 1194 women. The final end reference standard, which included histologic investigation, 2-year follow-up imaging, or clinical examination, was compared to the results. Both invasive malignancies and borderline tumors—tumors that are histologically malignant but do not have a destructive stromal invasion—were included in the PPVs for malignancy. In the study by Thomassin-Naggara et al., the O-RADS MRI risk score had an overall accuracy of 92%, with 93% sensitivity, 91% specificity, 71% positive predictive value, and 98% negative predictive value. The O-RADS MRI risk score that is currently available on the ACR website was created using the data from this study by the ACR O-RADS MRI committee".[73]

Figure 9: "O-RADS MRI Risk Stratification System (six risk score categories)"

ACR O-RADS MRI LEXICON: THE BASICS[77]

"The lexical descriptor phrases for signal intensity, physiologic finding versus lesion, and fluid versus solid seeming observations will be examined in brief in order to help you grasp the terminology used in the O-RADS MRI risk classification method".

- ✓ **Signal Intensity**

For every image, the signal intensity of the solid and fluid elements is characterized as either homogenous or heterogeneous. The intensity of a homogeneous signal is consistent or even in appearance. The appearance of a "heterogeneous signal intensity is nonuniform or uneven".

Signal intensity is classified as hypointense, moderate, or hyperintense. The signal intensity at high b-value diffusion-weighted imaging (DWI) is classified as low or high (with respect to cerebrospinal fluid or urine)

- **Lesion Types**

Lesion: "A finding associated with the ovary or adnexa that is not related to normal physiology. A cyst with or without solid components can be classified as a lesion, as can a solid lesion. Cysts are lesions that hold fluid and can have one or more eyes. At least 80% of the increasing solid tissue makes up a solid lesion".

- ✓ **Fluid Descriptors**

A cyst's fluid may be simple or complex. Endometriotic, hemorrhagic, proteinaceous, or lipid-containing fluids are examples of non-simple fluids. On T1-weighted, T2-weighted, and DWI scans, "simple fluid exhibits the same signal intensity as cerebrospinal fluid; on T1-weighted images, it is hypointense, and on T2-weighted images, it is hyperintense. On T1-weighted pictures, endometriotic fluid is homogeneous and hyperintense; on T2-weighted images, or shading, the signal intensity is hypointense or intermediate. The signal intensity of hemorrhagic fluid varies according on the duration elapsed since the bleed (Table 1). The signal strength of proteinaceous fluid varies; on T2-weighted imaging, it can be hypointense or hyperintense. On T1-weighted images, it can be hypointense. In adnexal lesions, proteinaceous fluid comprises mucin, pus, and colloid. Lipid-containing fluid can be confused for hemorrhagic or endometriotic fluid because it appears hyperintense on T2- and T1-weighted images. On fat-saturated imaging, however, lipid-containing fluid will exhibit a discernible drop in signal intensity. Unlike macroscopic fat, which shows signal loss on fat-saturated pictures, microscopic or intravoxel fat is best shown on opposed-phase images".

- ✓ **Solid Component Descriptors**

Any portion of "an adnexal lesion that is not fluid appears as a solid. Both solid tissue and other solid constituents are included in this (ie, nonsolid tissue). Strictly speaking, solid tissue is any solid component that becomes more visible after the administration of contrast material and possesses one or more of the following morphologic traits: papillary projections, mural nodules, irregular septations or walls, and a larger solid section. Other solid components that do not meet the criteria for solid tissue are referred to as nonsolid tissue. Examples of nonsolid tissue include blood clots, fat, fibrin threads, thin or thick smooth septations or walls, and nonenhancing detritus. Finding solid tissue inside an adnexal lesion is crucial because it increases the possibility that the lesion is cancerous. A nonsolid tissue discovery is not harmful".

Figure 10: O-RDS MRI Risk Stratification and Management System

O-RADS MRI Risk Stratification and Management System

O-RADS MRI Score	Risk Category	Positive Predictive Value for Malignancy^	Lexicon Description
0	Incomplete Evaluation	N/A	N/A
1	Normal Ovaries	N/A	No ovarian lesion
			Follicle defined as simple cyst ≤ 3 cm in a premenopausal woman
			Hemorrhagic cyst ≤ 3 cm in a premenopausal woman
			Corpus luteum +/- hemorrhage ≤ 3 cm in a premenopausal woman
2	Almost Certainly Benign	<0.5%^	Cyst: Unilocular- any type of fluid content ▪ No wall enhancement ▪ No enhancing solid tissue*
			Cyst: Unilocular – simple or endometriotic fluid content ▪ Smooth enhancing wall ▪ No enhancing solid tissue
			Lesion with lipid content** ▪ No enhancing solid tissue
			Lesion with "dark T2/dark DWI" solid tissue ▪ Homogeneously hypointense on T2 and DWI
			Dilated fallopian tube - simple fluid content ▪ Thin, smooth wall/endosalpingeal folds with enhancement ▪ No enhancing solid tissue
			Para-ovarian cyst – any type of fluid ▪ Thin, smooth wall +/- enhancement ▪ No enhancing solid tissue
3	Low Risk	~5%^	Cyst: Unilocular – proteinaceous, hemorrhagic or mucinous fluid content*** ▪ Smooth enhancing wall ▪ No enhancing solid tissue
			Cyst: Multilocular - Any type of fluid, no lipid content ▪ Smooth septae and wall with enhancement ▪ No enhancing solid tissue
			Lesion with solid tissue (excluding T2 dark/DWI dark) ▪ Low risk time intensity curve on DCE MRI
			Dilated fallopian tube – ▪ Non-simple fluid: Thin wall /folds ▪ Simple fluid: Thick, smooth wall/ folds ▪ No enhancing solid tissue
4	Intermediate Risk	~50%^	Lesion with solid tissue (excluding T2 dark/DWI dark) ▪ Intermediate risk time intensity curve on DCE MRI ▪ If DCE MRI is not feasible, score 4 is any lesion with solid tissue (excluding T2 dark/DWI dark) that is enhancing ≤ myometrium at 30-40s on non-DCE MRI
			Lesion with lipid content ▪ Large volume enhancing solid tissue
5	High Risk	~90%^	Lesion with solid tissue (excluding T2 dark/DWI dark) ▪ High risk time intensity curve on DCE MRI ▪ If DCE MRI is not feasible, score 5 is any lesion with solid tissue (excluding T2 dark/DWI dark) that is enhancing > myometrium at 30-40s on non-DCE MRI
			Peritoneal, mesenteric or omental nodularity or irregular thickening with or without ascites

^Approximate PPV based on data from Thomassin-Naggara, et al. O-RADS MRI Score for Risk Stratification of Sonographically Indeterminate Adnexal Masses. JAMA Network Open. 2020;3(1):e1919896. Please note that the PPV provided applies to the score category overall and not to individual characteristics. Definitive PPV are not currently available for individual characteristics. The PPV values for malignancy include both borderline tumors and invasive cancers.

* Solid tissue is defined as a lesion component that enhances and conforms to one of these morphologies: papillary projection, mural nodule, irregular septation/wall or other larger solid portions.

** Minimal enhancement of Rokitansky nodules in lesion containing lipid does not change to O-RADS MRI 4.

*** Hemorrhagic cyst ≤3cm in pre-menopausal woman is O-RADS MRI 1.

DCE = dynamic contrast enhancement with a time resolution of 15 seconds or less

DWI = diffusion weighted images

MRI = magnetic resonance imaging

O-RADS MRI SCORES: DEFINITIONS AND MALIGNANCY RISK[77]

- **O-RADS MRI Score 0**

When an MRI evaluation of an adnexal lesion is insufficient, the lesion is categorized as O-RADS MRI 0. This could involve lesions that are only partially scanned, with certain areas of the lesion left unassessed. This category also includes technically subpar MRI exams, such as those with a lot of artifact or without all necessary imaging sequences completed.[77]

- **O-RADS MRI Score 1**

When the ovaries are normal, an O-RADS MRI score of 1 is assigned. "Follicles, hemorrhagic cysts, and corpus luteal cysts of 3 cm or less are examples of physiological observations in premenopausal women that are not classed as adnexal lesions and can be assigned an O-RADS MRI score of 1. Premenopausal women frequently have corpus luteal cysts, hemorrhagic cysts, and follicles; when these conditions are detected, they should be properly reported. Very few follicles may remain in normal postmenopausal women's ovaries; if the radiologist concludes, based on subjective judgment, that the ovaries are normal, the ovaries may be classified as O-RADS MRI 1. However, if the radiologist determines that a finding does not match that of a normal ovary, it is referred to as an adnexal lesion and would be scored as O-RADS MRI 2-5. Lesions excluded from the O-RADS MRI risk score are those that are found to be nonadnexal or nonovarian in origin".[77]

- **O-RADS MRI Score 2**

With a probability of less than 0.5% for malignancy, adnexal lesions with an "O-RADS MRI score of 2 are virtually definitely benign (Fig 4).[8] It is crucial to apply this score exclusively to an adnexal lesion in both premenopausal and postmenopausal women. For observations not classified as an adnexal lesion, refer to the O-RADS MRI Score 1 section above".

Simple and nonsimple fluid unilocular cystic lesions fall into the "O-RADS MRI score 2 category. The sort of fluid is not a contributing element if there is a

unilocular cystic lesion without wall enhancement. Therefore, O-RADS MRI 2 is the score assigned to all cystic lesions that lack wall enhancement. O-RADS MRI 2 is assigned to proteinaceous and hemorrhagic unilocular cystic lesions (apart from physiologic findings) that lack enhancing walls and solid tissue. On the other hand, O-RADS MRI 3 is assigned to unilocular cystic lesions with proteinaceous or hemorrhagic fluid that have an enhancing wall. Regardless of wall enhancement, unilocular cystic lesions with simple and endometriotic fluid and no solid tissue are categorized as O-RADS MRI 2. Endometriomas may show a specific ancillary finding of linear foci in the wall or dark (low-signal-intensity) nodules on T2-weighted imaging".

O-RADS MRI 2 lesions (mature teratomas or dermoids) are defined as having a lipid content. On T1- and T2-weighted pictures, the "macroscopic lipid content within the lesion will be hyperintense, and on fat-saturated imaging, the signal intensity will decrease". With the exception of a Rokitansky nodule, dermoids often lack enhancing elements (Fig. E1 [online]). Rokitansky nodules often have fat inside of them and can get bigger. Malignant degeneration affects only 1% of dermoids and is extremely uncommon. On MRI images, malignant degeneration in dermoids is associated with a greater amount of solid tissue than is normal for a Rokitansky nodule. The prognosis for a dermoid that has undergone malignant transformation depends on its stage, and long-term survival is enhanced by early identification. "Thus, in MRI images, a fatty lesion is classed as O-RADS MRI 4 when there is a subjectively judged big volume of tissue (particularly with uneven borders) within the lesion".

"O-RADS MRI 2 can be applied to lesions that show homogenously hypointense signal intensity on both T2-weighted and high-b-value DWI scans (henceforth referred to as dark T2/dark DWI lesions). O-RADS MRI score is unaffected by the enhancing pattern of homogenously dark T2/dark DWI lesions. The ACR O-RADS MRI committee coined the phrase "dark T2/dark DWI" to describe fibrous tissue-containing lesions, which are most frequently benign ovarian fibromas and fibrothecomas".

Both "dilated fallopian tubes with simple fluid and no enhancing solid tissue and paraovarian cysts devoid of solid tissue can be classified as O-RADS MRI 2

lesions. It's important to be cautious when treating a hydrosalpinx so as not to confuse papillary projections with increasing endosalpingial folds. To help avoid this mistake, coronal or sagittal T2-weighted scans can be used to confirm that a hydrosalpinx is tubular in character".[77]

- **"O-RADS MRI Score 3"**

"Adnexal lesions with an O-RADS MRI 3 classification are thought to have a 5% probability of being malignant, making them low risk lesions overall.

This group includes unilocular cystic lesions with smooth increasing walls and hemorrhagic or proteinaceous fluid content (e.g., mucinous fluid) and no solid tissue, as well as any multilocular (nonfatty) cyst with smooth augmenting walls and septations but no enhancing solid tissue. Although there is extremely little chance of malignancy (PPV <3%) in these multilocular cysts without solid tissue, malignancies that have been found in this category include invasive and borderline tumors.[8] To guarantee the best outcome for these women, as is the case with all ovarian malignancies, it is prudent to evaluate women who may have early-stage cancer as soon as possible. Endometriomas can occasionally be multilocular or look multilocular because of ovarian parenchyma that mimics septations between the endometriomas. Multilocular endometriomas should be categorized as O-RADS MRI 2".[77]

"Solid tissue that is enhancing will aid in directing the O-RADS MRI risk score classification. If the solid tissue shows uniformly low signal intensity on both T2-weighted and high-b-value DWI scans (T2 dark/DWI dark lesion), the lesion is classified as O-RADS MRI 2. The solid tissue's TIC enhancement properties in relation to the outside myometrium will determine the score if it does not fit the homogenously T2 dark/DWI dark pattern. The lesion can be given an O-RADS MRI 3 risk score if the enhancement coincides with the low-risk TIC. The PPV for malignancy in lesions with a low-risk TIC is 6.7%, and the majority of malignant lesions in this group are borderline tumors".[8]

"Dilated fallopian tubes with thick, smooth enhancing walls and/or folds, or nonsimple fluid, are given an O-RADS MRI score of 3. There is little information available on the relative risk of cancer in women who have these findings.

However, the committee acknowledged that these types of findings should be placed in this category until more data are available, given that high-grade serous carcinomas originate from the fallopian tubes and that early-stage disease appearance is currently poorly described in the literature. The PPV for malignancy will be revised and, if necessary, reassigned into a new category when more data become available. Reminder: The O-RADS MRI score should not be used if the patient has acute symptoms and signs of dilated fallopian tubes. This will prevent pelvic inflammatory disease with pyosalpinx from being rated".[77]

- **"O-RADS MRI SCORE 4"**

"Adnexal mass with an O-RADS MRI 4 score are regarded as having an intermediate risk of cancer, with a 50% PPV for cancer.

This category includes solid tissue lesions with the intermediate-risk TIC (not T2 dark/DWI dark lesions). Data show that lesions with an intermediate TIC have a 46.6% PPV.8 If DCE MRI is not feasible, solid tissue lesions in non-DCE MRI images (apart from T2 dark/DWI dark lesions) that enhance less than or equal to the myometrium 30–40 seconds after contrast material injection might be placed in this category. To our knowledge, no research has calculated the probability of cancer for solid tissue that grows less than or equivalent to the myometrium at 30–40 seconds using non-DCE MRI (three-dimensional ultrafast gradient echo). The ACR O-RADS MRI committee determined that lesions that enhance less than or equal to the myometrium at 30–40 seconds should be classified as O-RADS MRI score 4 in the absence of DCE MRI. This is because very early enhancement, which is not as steep as that of the myometrium, is the basis for the definition of intermediate-risk TIC. The committee acknowledged that although DCE MRI examination is the preferred approach for risk score assignment, non-DCE MRI can be utilized in circumstances when DCE MRI is not practical".[77]

- **O-RADS MRI score 5**

"With a 90% PPV for malignancy, adnexal lesions with an O-RADS MRI score of 5 are thought to be at high risk of becoming malignant (Fig 7).

Lesions with solid tissue that have a high-risk TIC and/or peritoneal and/or omental deposits fall into this group (apart from T2 dark/DWI dark lesions). Lesions with a high-risk TIC have an 85.6% PPV, according to data.[8] If DCE MRI is not feasible, lesions containing solid tissue (apart from T2 dark/DWI dark lesions) that brighten more than the myometrium 30–40 seconds after contrast material administration can be categorized in this group. Given that the idea of high-risk TIC is based on very early enhancement steeper than that of the myometrium in the absence of DCE, the ACR O-RADS MRI committee decided to assign an O-RADS MRI score of 5 to lesions that enhance more than the myometrium at 30–40 seconds. The committee acknowledged the use of non-DCE MRI in situations when DCE MRI is not feasible, despite the fact that DCE MRI evaluation is the recommended approach".[77]

"Ovarian-Adnexal Reporting and Data System Ultrasound (O-RADS US)"[78, 79]

"The Ovarian-Adnexal Reporting and Data System Ultrasound (O-RADS US) forms the ultrasound component of the Ovarian-Adnexal Reporting and Data System (O-RADS). This system aims to ensure that there are uniform unambiguous sonographic evaluations of ovarian or other adnexal lesions, accurately assigning each lesion to a risk category of malignancy being present, which informs the appropriate management to be instituted".

"US is the primary imaging modality used to assess the ovaries and adnexa. An evidence-based lexicon for ovarian and adnexal lesions was presented in a 2018 American College of Radiology white paper, which also launched the OvarianAdnexal Reporting and Data System (O-RADS) US.
The O-RADS US risk stratification system, which uses sonographic morphologic characteristics to indicate malignancy, was implemented in 2019 and came with management guidelines. Numerous retrospective studies conducted in both selected and nonselected populations since its inception have shown that O-RADS US has a high sensitivity and specificity for identifying benign and malignant lesions".

“CLINICAL FEATURES AND ORADS APPLICATION”

“Depending on the size of the tumor and the stage of the disease, ovarian neoplasms can present with a wide range of nonspecific symptoms. Younger women are more likely to develop germ cell tumors than epithelial cell neoplasms, which typically appear in older women. The following are risk factors for epithelial ovarian cancer: advanced age, obesity, increased ovulatory cycles, hormone therapy, familial cancer syndromes (BRCA1, BRCA2, Lynch syndrome, Peutz-Jeghers syndrome), and fertility treatments.

Menopausal status is important for risk assessment and management, thus patients should be classified as premenopausal or postmenopausal.

- Postmenopausal defined as amenorrhea 1 year
- If uncertain or uterus is absent, manage as postmenopausal if age is > 50 years”

“When a potential adnexal lesion to be evaluated with US is shown by another modality (e.g., CT), O-RADS application to physiologic findings is advised for screening US examinations of patients who are at high risk (e.g., carriers of BRCA mutations). O-RADS applies only to lesions involving the ovaries or fallopian tubes. If a pelvic lesion origin is indeterminate but suspected to be an ovarian or fallopian tube in origin, then the O-RADS system may apply. If a pelvic lesion is identified as not ovarian or tubal in origin, then the ORADS system would be appropriate only in the case of a para-ovarian cyst or peritoneal inclusion cyst and, otherwise, does not apply”.

“Pelvic inflammatory disease, ectopic pregnancy, and torsion of a normal ovary are to be excluded while using ORADS-US for categorization”.

“ULTRASOUND TECHNIQUES

A transvaginal scan is recommended to optimally assess the ovarian and adnexal pathology. To assess possible pathologic problems outside the focal length of the vaginal transducer, the patients are examined with an abdominal transducer.
To prepare the transducer for a transvaginal scan, standard coupling gel is applied

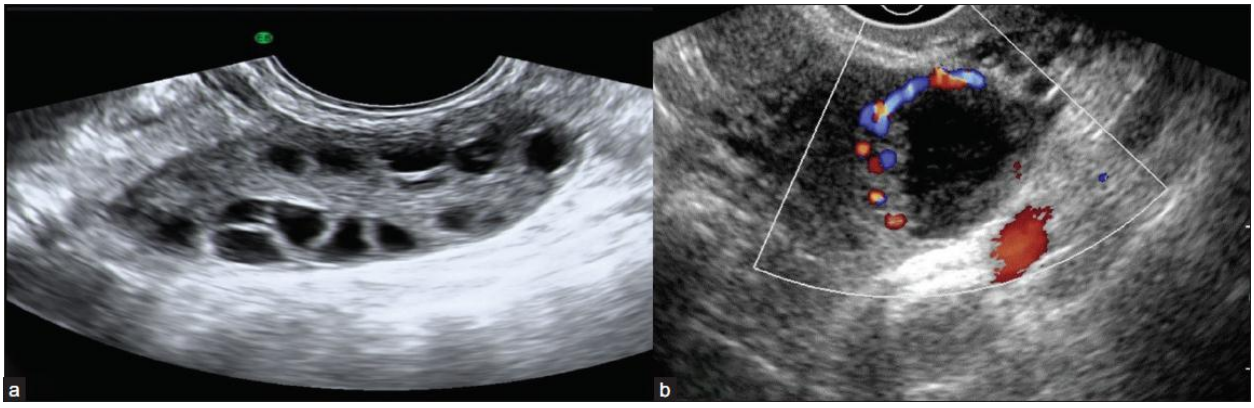
first. Next, a probe cover is inserted and again lubricated with coupling gel. When the uterus is retroverted, the transducer is inserted into the posterior vaginal fornix; when it is anteverted, it is inserted into the anterior vaginal fornix.

The observations include the size, form, and echotexture of the ovarian or adnexal masses in the transverse and sagittal planes. Despite these methods, the lesion is classified as ORADS 0 if the study is insufficient and cannot be assigned to an ORADS score or if additional imaging is needed".

NORMAL OVARY (O-RADS 1)

The O-RADS 1 category includes physiologic follicles, and the corpus luteum of the ovary which may measure up to 3 cm and do not require further follow-up.

Figure 11: (a) "A premenopausal woman's typical ovary with numerous peripheral follicles, uniform echotexture, and a central echogenic medulla is shown on a greyscale ultrasound image. (b) In a premenopausal female, a thick-walled cystic lesion with crenulated inner walls, few internal echoes, and peripheral vascularity indicating a corpus luteal cyst is shown on a colour Doppler image".



Classification

"For risk stratification, the O-RADS US system uses five categories (O-RADS 1–5), from normal (1) to high risk of malignancy (5). An O-RADS US 0 (zero) category is used for an incomplete evaluation".

An external diagnostic validation study has suggested that both the O-RADS lexicon and the IOTA 2-step strategy are effective in stratifying patients into risk

groups. However, the observed malignancy rate in O-RADS 2 was approximately 1.1%, not clearly below 1%.

“O-RADS US 0

- an incomplete evaluation

O-RADS US 1

Physiologic category (normal premenopausal ovary)

- ovarian follicle (<3 cm)
- corpus luteum (typically <3 cm)”

“O-RADS US 2

Almost certainly benign category (<1% risk of malignancy) - consider gynecology referral for cases that require imaging follow-up

- simple cyst 3-5 cm
    - premenopausal: no follow-up
    - postmenopausal: 1-year follow-up
- simple cyst 5-10 cm
    - premenopausal: 1-year follow-up
    - postmenopausal: 1-year follow-up
- non-simple but smooth unilocular cyst OR smooth bilocular cyst <3 cm
    - premenopausal: no follow-up
    - postmenopausal: 1-year follow-up
- non-simple but smooth unilocular cyst OR smooth bilocular cyst 3-10 cm

    - premenopausal: 6-month follow-up
    - postmenopausal: 6-month follow-up”
- “lesions with "classical ultrasound characteristics" of the following but may have specific recommendations and measure < 10 cm:
    - typical hemorrhagic cyst
    - dermoid cyst
    - endometrioma
    - paraovarian cyst
    - peritoneal inclusion cyst
    - hydrosalpinx”

“O-RADS US 3

Low risk of malignancy (1% to <10%) - needs a referral to ultrasound specialist or gynecologist with a view to MRI

- unilocular or bilocular >10 cm (simple or non-simple)
- lesions looking like typical dermoids, endometriomas, or hemorrhagic cysts >10 cm
- multilocular cyst <10 cm smooth inner wall with color score 1-3
- solid lesion - smooth outer contour, any size, color score 1
- solid lesion - smooth outer contour, any size, color score 2-3 with shadowing
- unilocular irregular cyst of any size”

“O-RADS US 4

Lesions with an intermediate risk of malignancy (10% to <50%) - needs ultrasound specialist review or MRI as well as management by a gynecologist with gynecological oncology support or solely by a gynecological oncologist

- unilocular cyst with a solid component, any size, 1-3 papillary projections, any color score
- multilocular cyst with solid component, any size, color score 1-2
- multilocular cyst without solid component
    - >10 cm, smooth inner wall with color score 1-3
    - any size smooth inner wall with color score of 4
    - any size with an irregular inner wall or irregular septations of any color score
- solid - smooth outer contour, any size, color score 2-3
- bilocular irregular cyst of any size, no solid components”

“**O-RADS US 5**

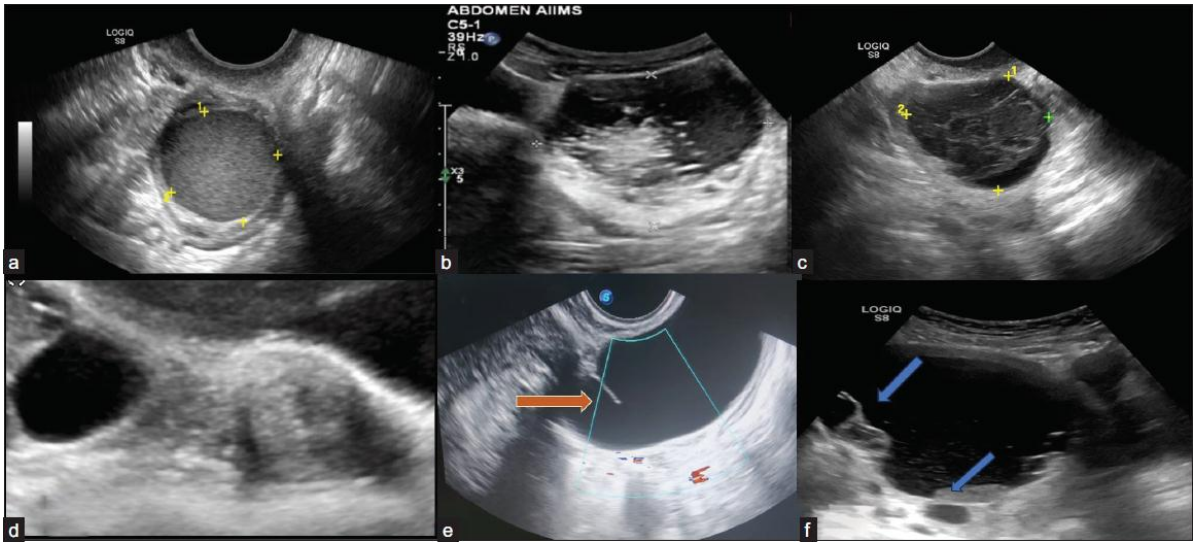
Lesions with a high risk of malignancy (≥50%) - needs a referral to a gynecological oncologist

- presence of ascites / peritoneal nodularity
- unilocular cyst with 4 or more papillary projections
- multilocular/bilocular cyst with a solid component - color score 3-4
- solid lesion - smooth outer contour, any size, color score 4
- solid lesion - irregular contour, any size, any color score”

“Color scoring (CS) indicator

- CS1: no flow
- CS2: minimal flow
- CS3: moderate flow
- CS4: strong flow”
-

Figure 12: “USG scans show lesions that are often benign. (a) Endometrioma, a unicular cyst exhibiting uniform echoes across the whole cyst. (b) Hyperechoic lines and spots that resemble coiled hair are another characteristic of a typical dermoid cyst, together with a hyperechoic component with shadowing. (c) A typical hemorrhagic cyst is a unilocular cyst that has a fine, intersecting internal reticular pattern. (d) A paraovarian cyst is indicated by a simple cyst that separates from the nearby ovary. (e) A typical hydrosalpinx is a tubular, fluid-filled structure with inadequate septation (arrow) that represents a fold and lacks internal echoes. (f) A peritoneal inclusion cyst is a collection of unilocular fluid that forms to the surrounding pelvic organs, with the ovary at the edge (upper arrow). There is little internal detritus, no mural nodularity, and no distinct limiting wall (lower arrow)”.



Figuer 13: A cystic adnexal lesion is visible on unilocular ultrasound pictures. For interval change and risk stratification, the biggest dimension is the average of the linear dimensions in three planes.

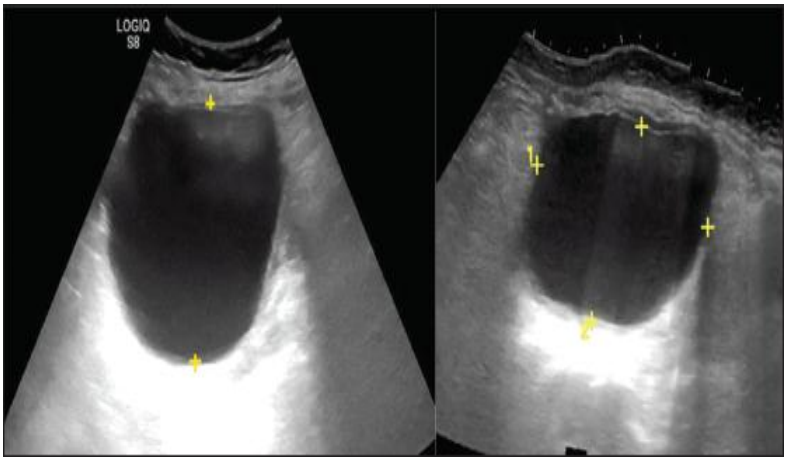


Figure 14: Three distinct individuals' cystic adnexal lesions on ultrasound (USG) pictures display various forms of locularity. Bilocular, multilocular, and unilocular

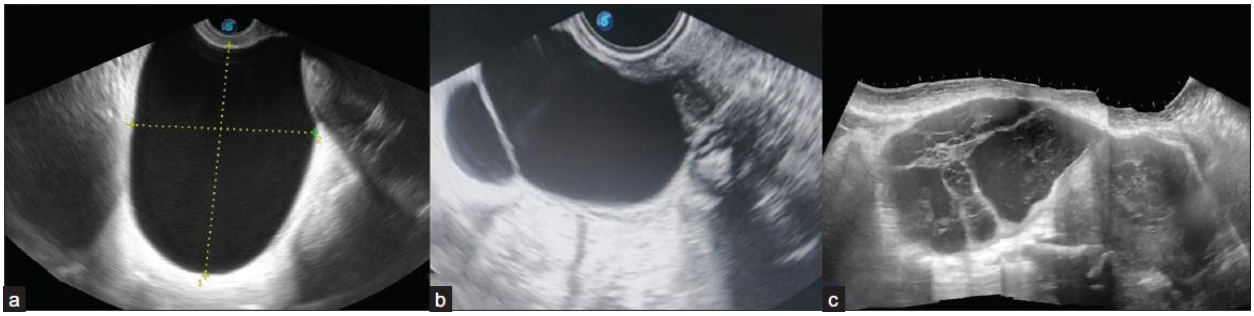


Figure 15: “images from “ultrasound (USG) that show the walls or inner edges of cystic lesions. (a) A unilocular cyst with internal echoes and a smooth inner wall edge is shown on the USG picture. (b) A unilocular margin with an uneven inner margin and non-simple fluid in the form of internal echoes are visible in the USG picture”.

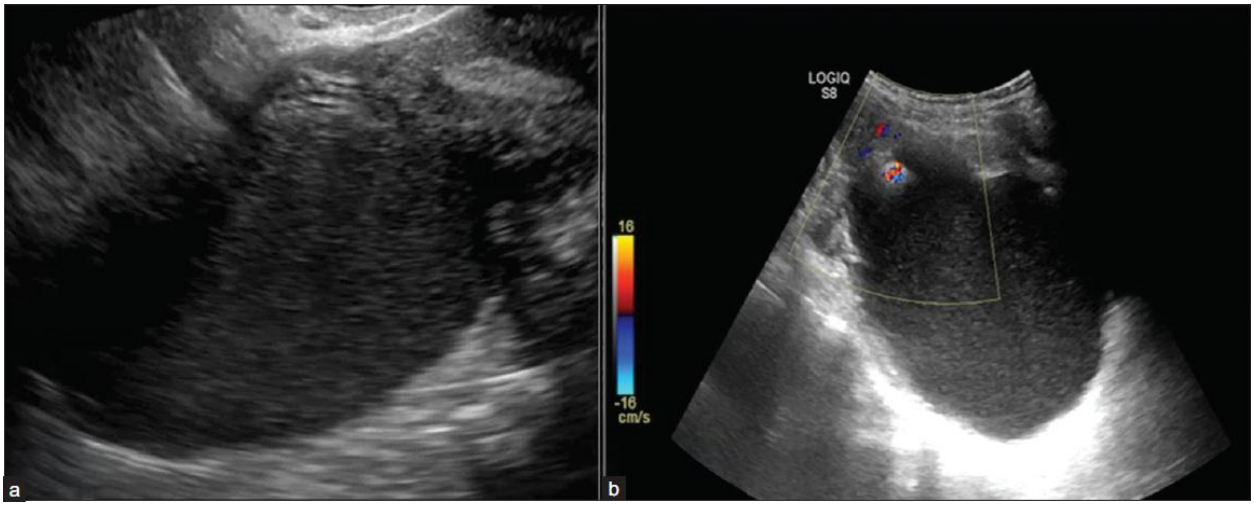


Figure 16: An ultrasound (USG) scan reveals a solid papillary projection together with a cystic lesion. It is necessary to estimate the echogenic component's height (green line). If it is 3 mm in height, it is regarded as a solid component; if it is less than 3 mm, it is regarded as a component of the wall's irregularity.

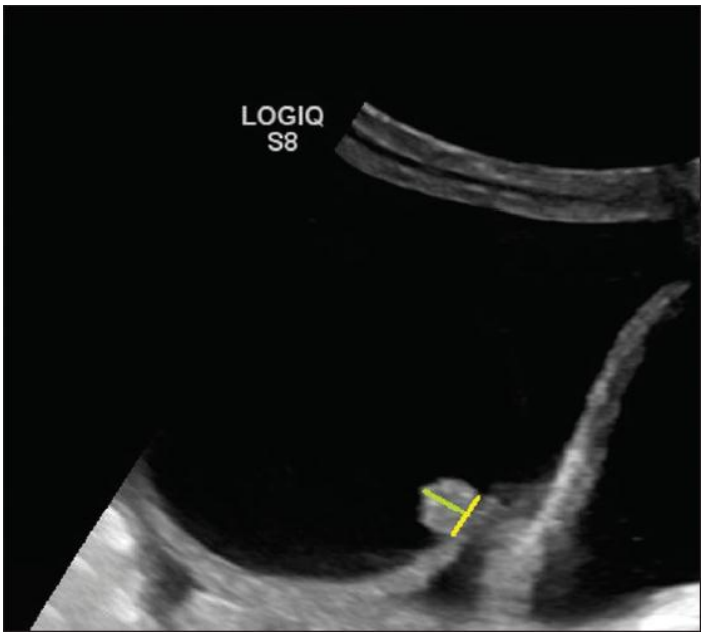


Figure 17: Different adnexal lesions with varying colour score patterns on ultrasound (USG) images: A colour score of one, a colour score of two, a colour score of three, and a colour score of four

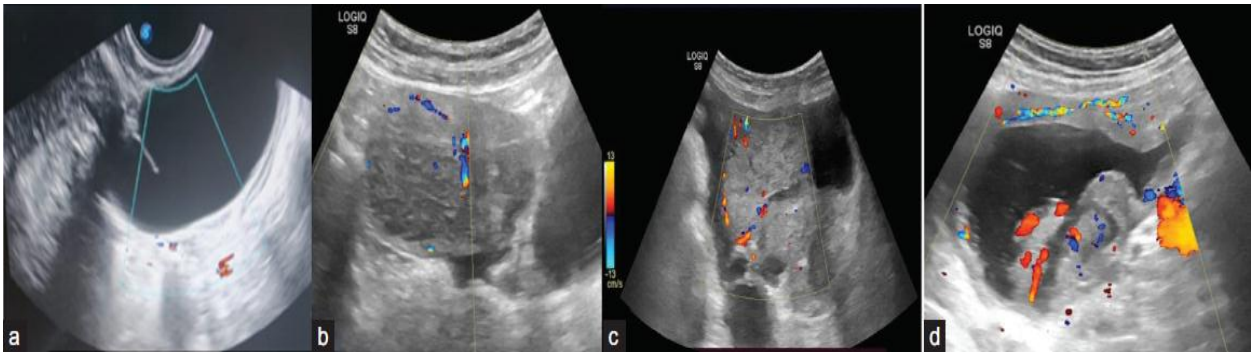


Figure 18: The "Ultrasound-Ovarian Adnexal Reporting and Data System (US-ORADS) is assigned for a cystic ovarian lesion using an algorithm."

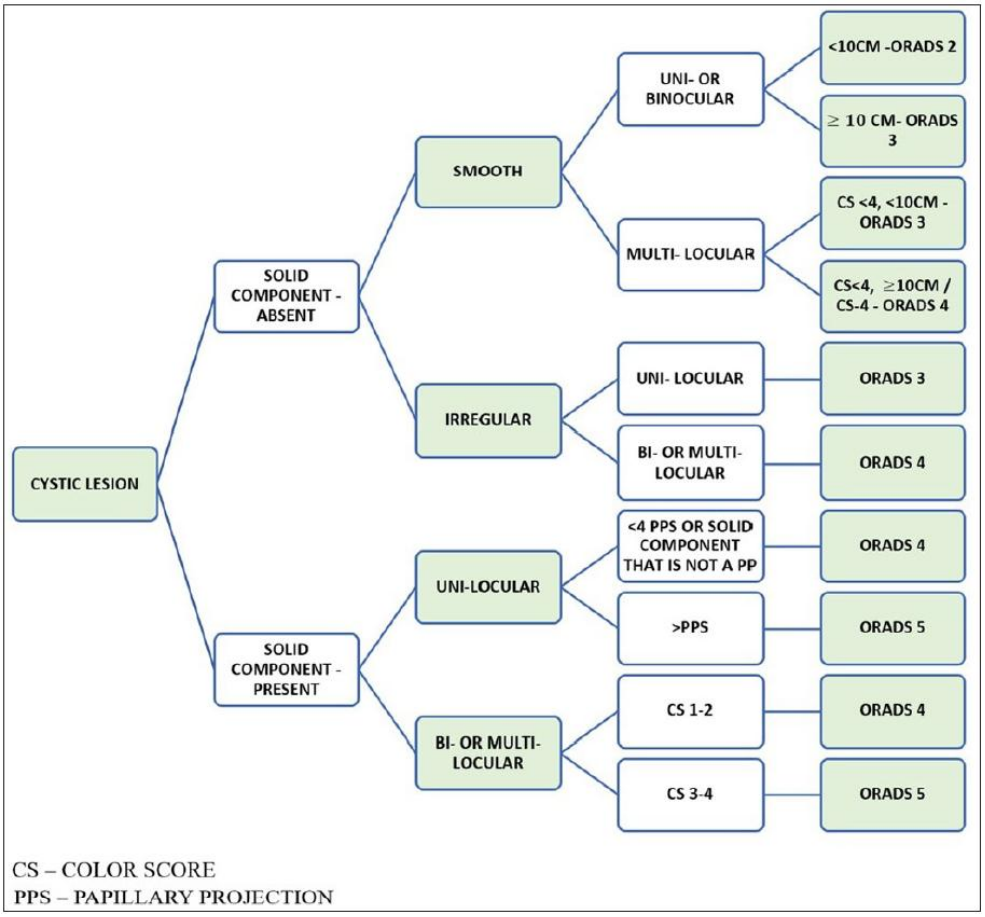
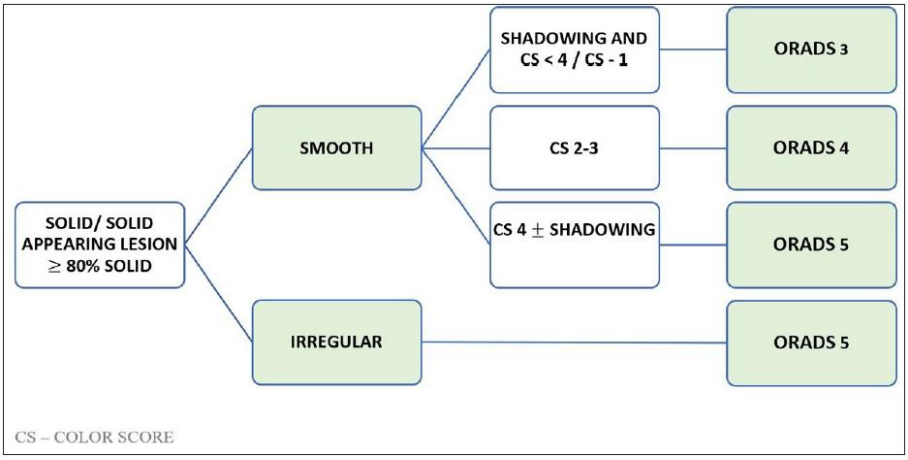


Figure 19: "Algorithmic approach to assign Ultrasound Ovarian-Adnexal Reporting and Data System US-ORADS for a solid ovarian lesion"



REVIEW OF RELATED ARTICLES

A study conducted by Patrick Nunes Pereira et al.(2022)[80] concluded that Our research supports "the use of the O-RADS MRI score for assessing adnexal masses, particularly those that are ultrasound-detected as indeterminate. The O-RADS MRI score" has recently undergone improvements that make it easier to understand and enable more widespread adoption without sacrificing diagnostic precision.

A study conducted by Ramya T et al.(2022)[81] concluded that The first imaging modality of choice for evaluating adnexal mass lesions is ultrasound. Nonetheless, using M.R.I. imaging has a high degree of accuracy for locating a mass's origin and assessing its tissue content, vascularity, and septal thickness for preoperative planning. M.R.I. has higher sensitivity and diagnostic precision than USG.

A study conducted by Dania Guadalupe Solis Cano et al. (2021)[82] concluded that for malignant vs. benign findings in our investigation, O-RADS classification produced a greater specificity than sensitivity. Thus, we suggest that this classification might be valuable for properly adjusting treatment. O-RADS 0 to 2 might benefit from conservative therapy, whereas O-RADS 3 to 5 might call for surgery.

In their research, Aslan et al. (2021)[83] demonstrated the O-RADS MRI score's "sensitivity of 96.3%, specificity of 95.2%, and accuracy of 95.3% in predicting malignancy. The O-RADS MRI score, which is based on a streamlined MRI technique, has good accuracy and validity in differentiating benign from malignant sonographically ambiguous adnexal masses. The AUC for this classification was 0.983".

Neeharika C et al (2021)[84] evaluated accuracy of ultrasound and magnetic resonance imaging in characterizing adnexal lesions. The current study described the advantages of MRI over USG in characterising the adnexal lesions as benign or malignant. MRI has better accuracy and specificity in recognising the malignant potential of the lesion which are 97% and 100% respectively ($p < 0.01$) because of its higher soft tissue resolution and better Multiplanar imaging.

A study conducted by pooja Varwatte et al.(2020)[85] concluded that serous cystadenomas are the most prevalent benign ovarian tumours and that benign lesions are more prevalent among adnexal lesions. In every suspected case of adnexal lesions, ultrasound is the first imaging modality used. We are able to diagnose them with a high degree of accuracy thanks to their distinctive ultrasonography characteristics. The accuracy of the ultrasonography in detecting adnexal lesions was generally comparable to that of the M.R.I., although the M.R.I. was superior at determining the extent and epicentre. By recommending ultrasound follow-up for benign lesions like simple ovarian cysts, haemorrhagic cysts, complex cysts, and hydrosalpinx, one can spare the patient an unnecessary financial burden. M.R.I. should only be advised for large lesions and suspected cases of cancer if the lesion does not shrink after ultrasound follow-up.

A 5-point Ovarian-Adnexal Reporting Data System Magnetic Resonance Imaging (O-RADS MRI) scoring system was used by Thomassin-Naggara et al. (2020)[86] in a large multicentric cohort study that was based on the results of the preliminary ADNEX MRI study to stratify the risk of sonographically indeterminate adnexal masses. For the study, histopathology and a two-year follow-up were used as reference standards. There were five risk categories on the score, and each showed a positive chance ratio for cancer. For scores 2, 3, and 4, the positive probability ratios for malignancy were 0.01, 0.27, 4.42, and 38.81, respectively. For seasoned readers, the area under the receiver operating characteristic curve was 0.96, with a sensitivity of 0.93 and a specificity of 0.91. With a sensitivity of 0.93 and specificity of 0.91, the O-RADS MRI score was determined to be reliable for risk categorization of adnexal masses.

A systematic review and meta-analysis were carried out by Anthoulakis C et al. (2014)[87] with the goal of critically evaluating pelvic MRI as the recommended advanced second imaging test for ovarian cancer detection and assessment of indeterminate adnexal masses, with regard to pre-operatively assigning these patients to the proper level of care. They came to the conclusion that the best post-test likelihood for ovarian cancer identification was offered by MRI combined with intravenous contrast. MRI's specificity in identifying several benign adnexal lesions is its primary benefit when evaluating adnexal masses. It has been

demonstrated that magnetic resonance imaging (MRI) is more precise and accurate than ultrasound (US) and Doppler evaluation, with accuracy rates ranging from 83% to 89%, as opposed to 63% with ultrasonography.

MATERIAL AND METHODS

- Study design: Hospital-Based Cross-Sectional Study
- Study area: Department of Radio-Diagnosis, Shri B. M. Patil Medical College and Hospital, Vijayapura, Karnataka, India.
- Study period: Research study was conducted from April 2023 to April 2025. Below is the work plan.

Table 3: Work plan of the study with percentage of allocation of study time and duration in months

Work plan	% of allocation of study time	Duration in months
Understanding the problem, preparation of questionnaire.	5-10%	April 2023 to June 2023
Pilot study, Validation of questionnaire, data collection and manipulation	Upto 80%	July 2023 to September 2024
Analysis and interpretation	5-10%	October 2024 to January 2025
Dissertation write-up and submission	5-10%	February 2025 to April 2025

- **Sample size:**

Sample size (n) = $(Z^2 * p*(1-p)) / d^2$

Where,

z is the z score= 1.96

d is the margin of error= 0.05

n is the population size

p is the population proportion =0.0294

The estimated sample size of this study is 44.

- **Inclusion criteria:**

1. All patients who are female and have ovarian mass lesions that are clinically suspected.
2. On U.S.G ovarian mass lesions were discovered by chance.
3. Patients ultrasonographic proved to ORADS 2 and above.

- **Exclusion criteria:**

1. Patients with ultrasound score of ORADS 1 and 2.
2. Cases of ectopic pregnancy that have been demonstrated clinically and by ultrasound.
3. All patients with cochlear implants, pacemakers for the heart, artificial heart valves, or other metallic implants.
4. Patients with claustrophobia in the past.

METHODOLOGY:

Study Design and Setting

This hospital-based cross-sectional study was conducted at the Department of Radiology, BLDE (Deemed to be University), Shri B M Patil Medical College Hospital & Research Centre, Vijayapura, between April 2023 and April 2025. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrollment.

Study Population and Sample Selection

Female patients aged between 12 and 85 years who presented with suspected ovarian masses or had incidental ultrasonographic findings suggestive of ovarian lesions were included in the study. Patients who were clinically suspected of having gynecological masses and those referred to the radiology department for evaluation were screened for eligibility. Detailed medical history was obtained from all participants, including presenting complaints, menstrual history, obstetric history, and family history of gynecological malignancies.

Clinical Examination and Data Collection

A thorough physical examination was performed for all participants by qualified gynecologists. Initial clinical findings were documented in a standardized proforma. Demographic data, clinical symptoms, and relevant laboratory investigations were recorded. Prior to imaging, all patients underwent routine blood investigations and tumor marker analysis as per standard hospital protocol.

Imaging Protocol

Ultrasonography Examination

All participants underwent transabdominal and/or transvaginal ultrasonography using GE VOLUSON S8 BT 18 and GE VERSANA PREMIER systems. The examination was performed by experienced radiologists following a standardized protocol. Both gray-scale and color Doppler imaging were utilized to evaluate the ovarian lesions. Lesion characteristics including size, morphology,

vascularity, and associated findings were documented according to the O-RADS US risk stratification system.

Magnetic Resonance Imaging

MRI examinations were performed using a GE SIGNA EXPLORER 1.5 TESLA system. Standard imaging protocols included T1-weighted, T2-weighted, fat-suppressed T1-weighted, and diffusion-weighted sequences in multiple planes. When indicated, contrast-enhanced sequences were obtained using gadolinium-based contrast agents after obtaining informed consent. The MRI features were analyzed and categorized according to the O-RADS MRI scoring system by radiologists who were blinded to the ultrasonography findings.

Image Analysis and Interpretation

Two experienced radiologists independently analyzed the ultrasonography and MRI findings. In cases of discrepancy, a consensus was reached through discussion with a third senior radiologist. The lesions were characterized based on their morphological features, enhancement patterns, and risk stratification scores according to both O-RADS US and O-RADS MRI systems.

Follow-up and Outcome Assessment

Participants were followed up to correlate imaging findings with surgical, histopathological, and clinical outcomes. For patients who underwent surgical intervention, detailed operative findings were recorded, and specimens were sent for histopathological examination. In cases managed conservatively, clinical and imaging follow-up was performed at regular intervals as per standard protocols.

Data Management and Quality Control

All data was recorded in pre-designed case report forms and subsequently entered into a computerized database. Regular quality checks were performed to ensure data accuracy and completeness. Patient confidentiality was maintained throughout the study period by using unique identification codes.

Histopathological Correlation

Surgical specimens, when available, underwent detailed histopathological examination by experienced pathologists who were blinded to the imaging findings. The histopathological diagnosis served as the gold standard for determining the diagnostic accuracy of both imaging modalities.

STATISTICAL ANALYSIS

SPSS version 21 was used to analyse the data after it was entered into an Excel sheet. The findings were displayed both graphically and tabularly. For quantitative data, the mean, median, standard deviation, and ranges were computed. The sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of MRI and ultrasonography were calculated to assess their diagnostic performance. Using the proper statistical tests, the agreement between the O-RADS US and O-RADS MRI grading systems was evaluated. Frequencies and percentages were used to express the qualitative data. The significance of the mean was tested using the student t test (two-tailed), and a P value of less than 0.05 was deemed significant.

RESULTS

The present study was conducted in the department of Radiodiagnosis at Shri B M Patil Medical College Hospital & Research Centre, Vijayapura from April 2023 – April 2025 to compare study of magnetic resonance imaging and ultrasonography in evaluation of ovarian lesions with emphasis on ovarian adnexal reporting and data system. Total of 44 patients were included in the study.

Following were the results of the study:

Table 4: Distribution of patients according to age

Age (in years)	Frequency	Percentage
17-20	2	4.5%
21-40	29	65.9%
41-60	8	18.2%
>60	5	11.4%
Total	44	100%

Table 4 and graph 1 shows the age distribution of the 44 study participants. The majority of patients (65.9%) were in the 21-40 years age group, followed by 18.2% in the 41-60 years group. Only 11.4% of patients were older than 60 years, and a small percentage (4.5%) were between 17-20 years. This distribution indicates that ovarian lesions in this study population were most common in reproductive-age women.

Graph 1: Distribution of patients according to age

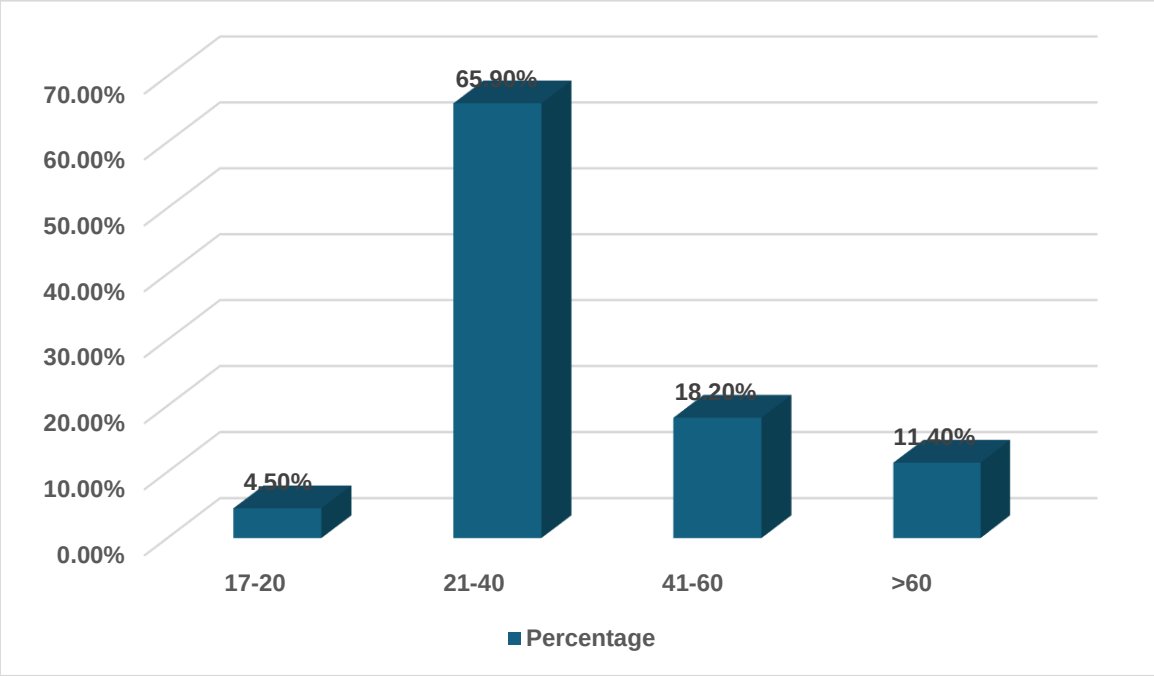


Table 5: Distribution of patients according to clinical presentation

Clinical presentation	Frequency	Percentage
Pain abdomen	40	90.9%
Mass per abdomen	1	2.3%
Back ache	2	4.5%
Amenorrhea	1	2.3%
Total	44	100%

Table 5 and graph 2 presents the clinical presentation of patients with ovarian lesions. The vast majority (90.9%) of patients presented with abdominal pain as their primary symptom. Less common presentations included back pain (4.5%), abdominal mass (2.3%), and amenorrhea (2.3%). This highlights that pain is the predominant symptom that brings patients with ovarian lesions to medical attention.

Graph 2: Distribution of patients according to clinical presentation

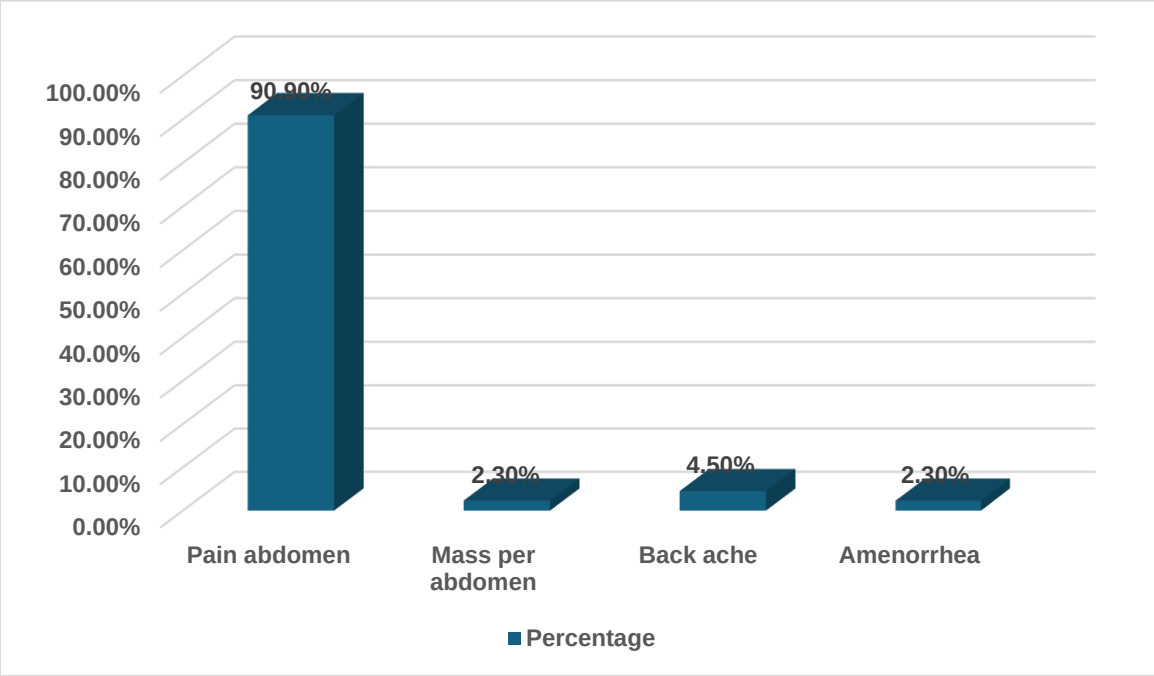


Table 6: Distribution of patients according to side of lesion

Side of lesion	Frequency	Percentage
Right	23	52.3%
Left	18	40.9%
Bilateral	3	6.8%
Total	44	100%

Table 6 and graph 3 details the distribution of ovarian lesions according to side. Right-sided lesions were slightly more common (52.3%) than left-sided lesions (40.9%). Bilateral lesions were relatively uncommon, occurring in only 6.8% of cases. This suggests a slight predilection for right-sided ovarian pathology in this study population.

Graph 3: Distribution of patients according to side of lesion

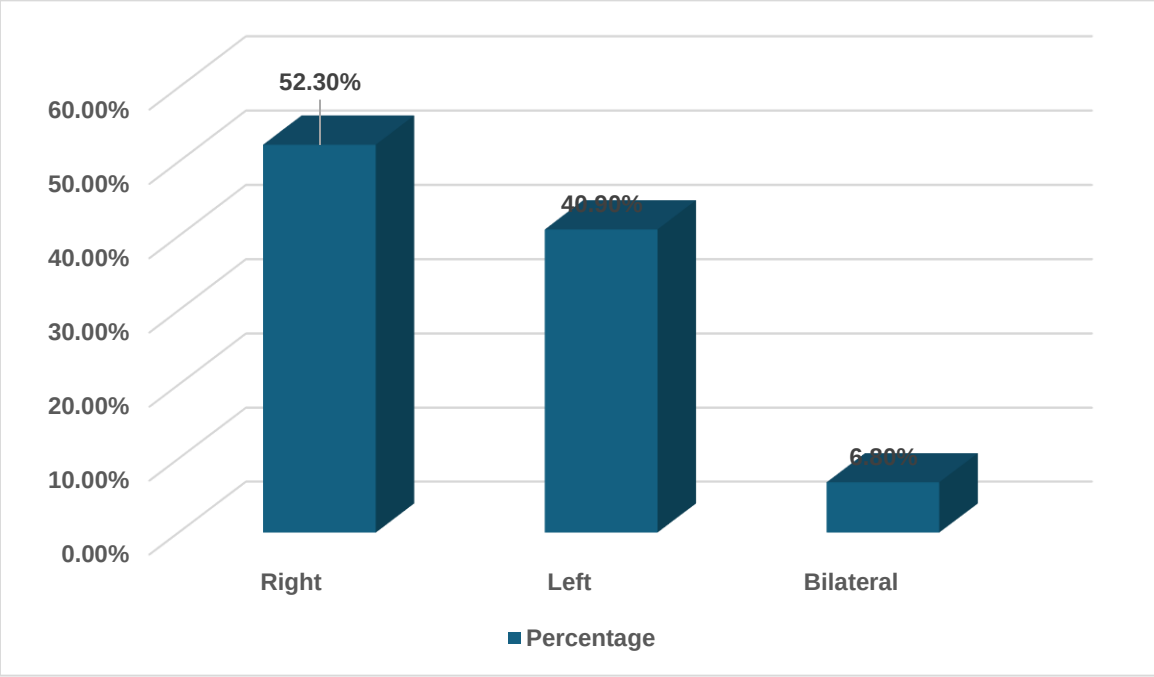


Table 7: Distribution of patients according to size of the lesion

Size of the lesion (mm)	
Mean	117.7
SD	22.8

Table 7 and graph 4 provides information about the size of the ovarian lesions. The mean size was 117.7 mm with a standard deviation of 22.8 mm. This indicates that most lesions were relatively large at the time of detection, with considerable variation in size among patients.

Graph 4: Distribution of patients according to size of the lesion

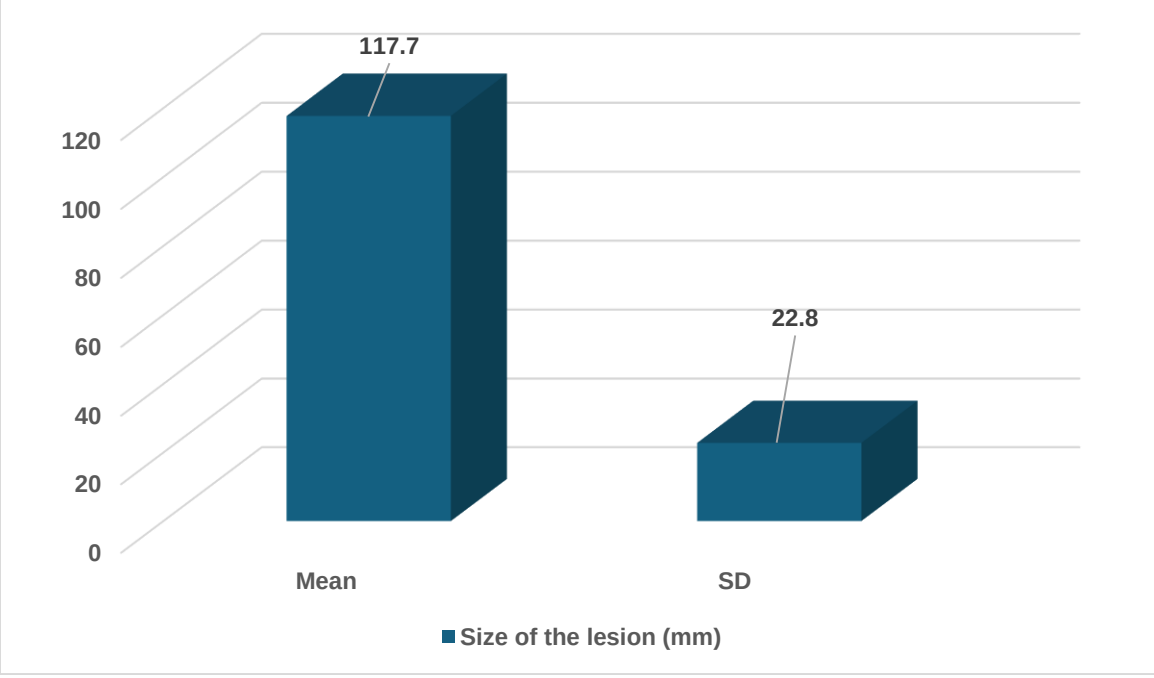


Table 8: Distribution of patients according to USG and MRI ORADS score

ORADS score	USG	MRI
3	27 (61.4%)	28 (63.6%)
4	9 (20.5%)	8 (18.2%)
5	8 (18.2%)	8 (18.2%)

Table 8 and graph 5 compares the O-RADS (Ovarian-Adnexal Reporting and Data System) scores between ultrasound and MRI. The distribution was similar between both modalities, with most lesions classified as O-RADS 3 (64.1% on USG and 63.6% on MRI), followed by O-RADS 4 (20.5% on USG and 18.2% on MRI) and O-RADS 5 (18.2% on both USG and MRI). This suggests good concordance between USG and MRI in assigning O-RADS scores.

Graph 5: Distribution of patients according to USG and MRI ORADS score

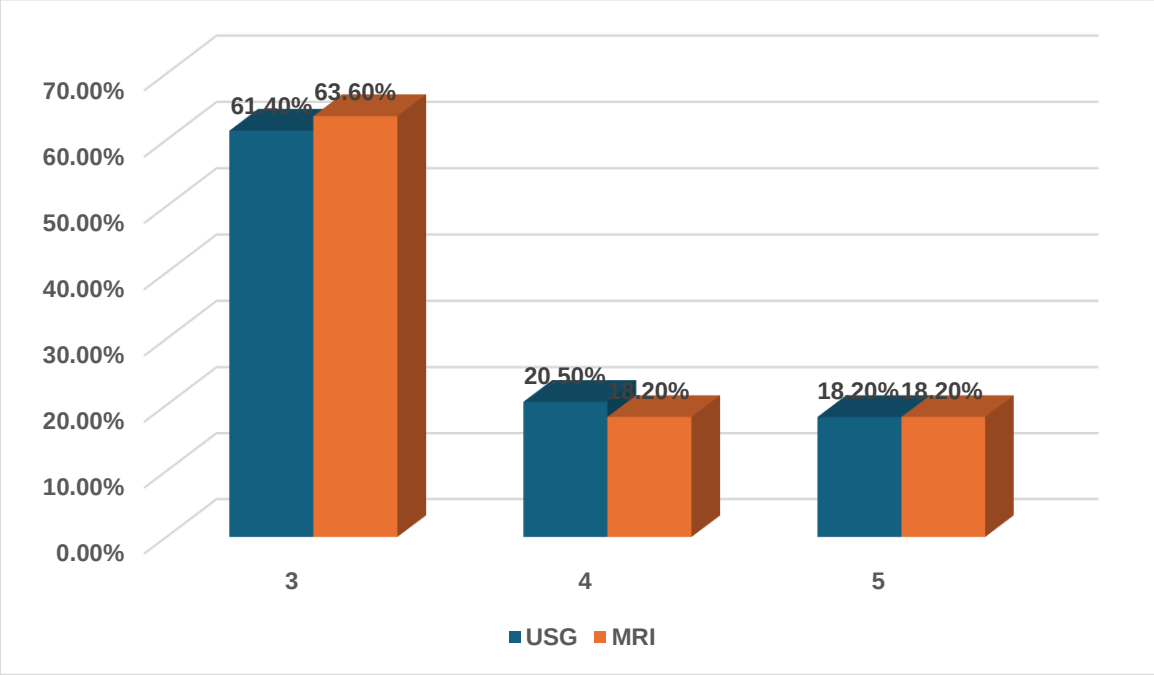


Table 9: Distribution of patients according to USG and MRI characteristics

Characteristics	USG	MRI
Unilocular cystic without solid component	10 (22.7%)	10 (22.7%)
Unilocular cystic solid component	8 (18.2%)	8 (18.2%)
Multilocular cystic without solid component	13 (29.5%)	13 (29.5%)
Multilocular cystic with solid component	5 (11.4%)	5 (11.4%)
Solid	8 (18.2%)	8 (18.2%)

Table 9 and graph 6 shows the morphological characteristics of the ovarian lesions as determined by USG and MRI. Both modalities identified identical proportions of various lesion types: multilocular cystic without solid component (29.5%), unilocular cystic without solid component (22.7%), solid lesions (18.2%), unilocular cystic with solid component (18.2%), and multilocular cystic with solid component (11.4%). This perfect agreement suggests excellent concordance between USG and MRI in characterizing ovarian lesion morphology.

Graph 6: Distribution of patients according to USG and MRI characteristics

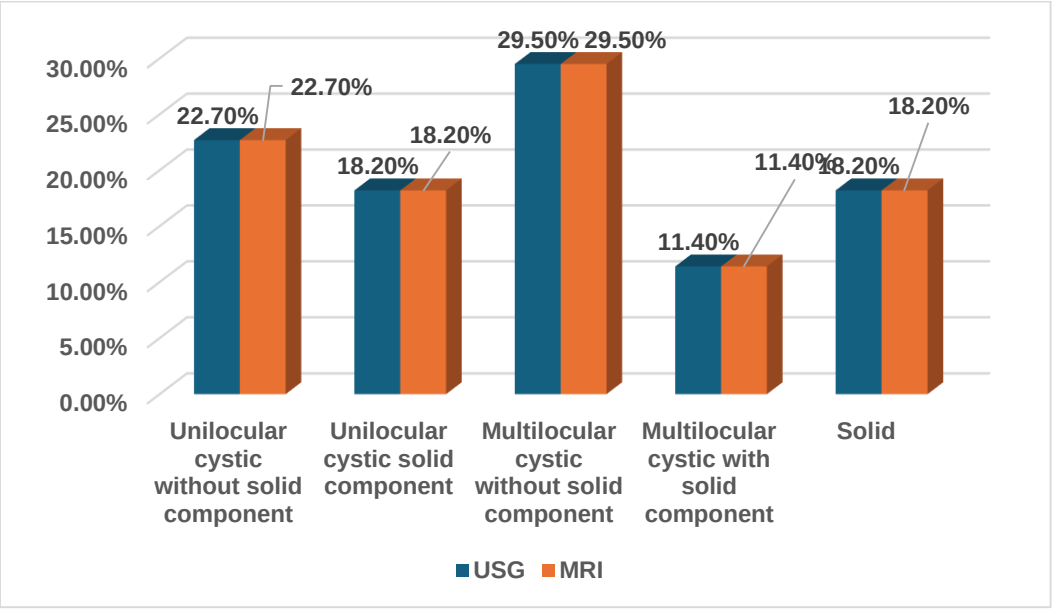


Table 10: Distribution of patients according to histopathology

Histopathology	Frequency	Percentage
Serous cystadenoma	10	22.7%
Endometrioma	3	6.8%
Mucinous cystadenoma	6	13.6%
Endometroid adenocarcinoma	2	4.5%
Peritoneal inclusion cyst	1	2.3%
Haemorrhagic cyst	5	11.4%
Fibroma	5	11.4%
Mature teratoma	2	4.5%
Serous cystadenocarcinoma	3	6.8%
Mucinous cystadenocarcinoma	3	6.8%
Yolk sac tumour	2	4.5%
Hydrosalphynx	2	4.5%

Table 10 and graph 7 presents the histopathological diagnosis of the ovarian lesions. Serous cystadenoma was the most common benign diagnosis (22.7%), followed by mucinous cystadenoma (13.6%), hemorrhagic cyst and fibroma (each 11.4%). Among malignant lesions, serous cystadenocarcinoma and mucinous cystadenocarcinoma were equally common (6.8% each). This diverse histopathological profile reflects the wide spectrum of ovarian pathologies encountered in clinical practice.

Graph 7: Distribution of patients according to histopathology

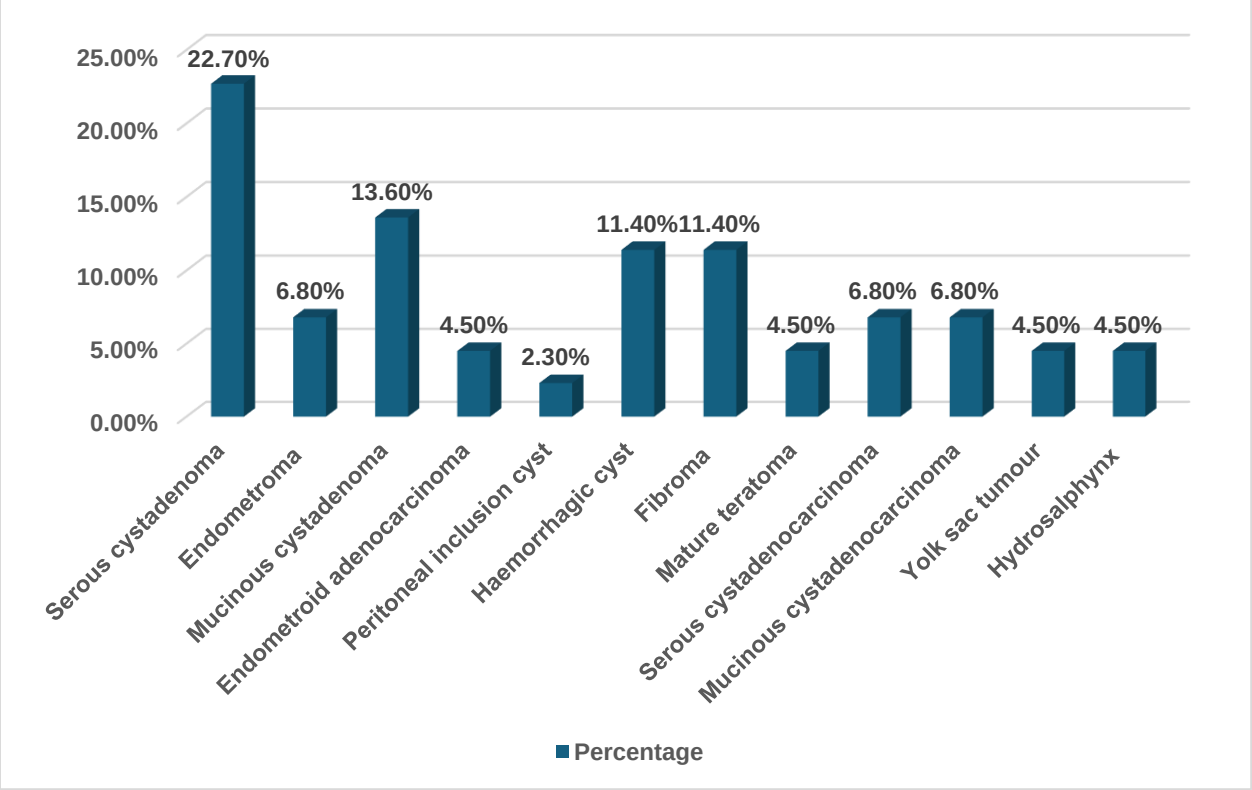


Table11: Distribution of patients according to final outcome

Final outcome	Frequency	Percentage
Benign	35	79.5%
Malignant	9	20.5%
Total	44	100%

Table 11 and graph 8 summarizes the final outcome based on histopathology, showing that 79.5% of lesions were benign and 20.5% were malignant. This distribution is consistent with epidemiological data suggesting that most ovarian masses are benign in nature.

Graph 8: Distribution of patients according to final outcome

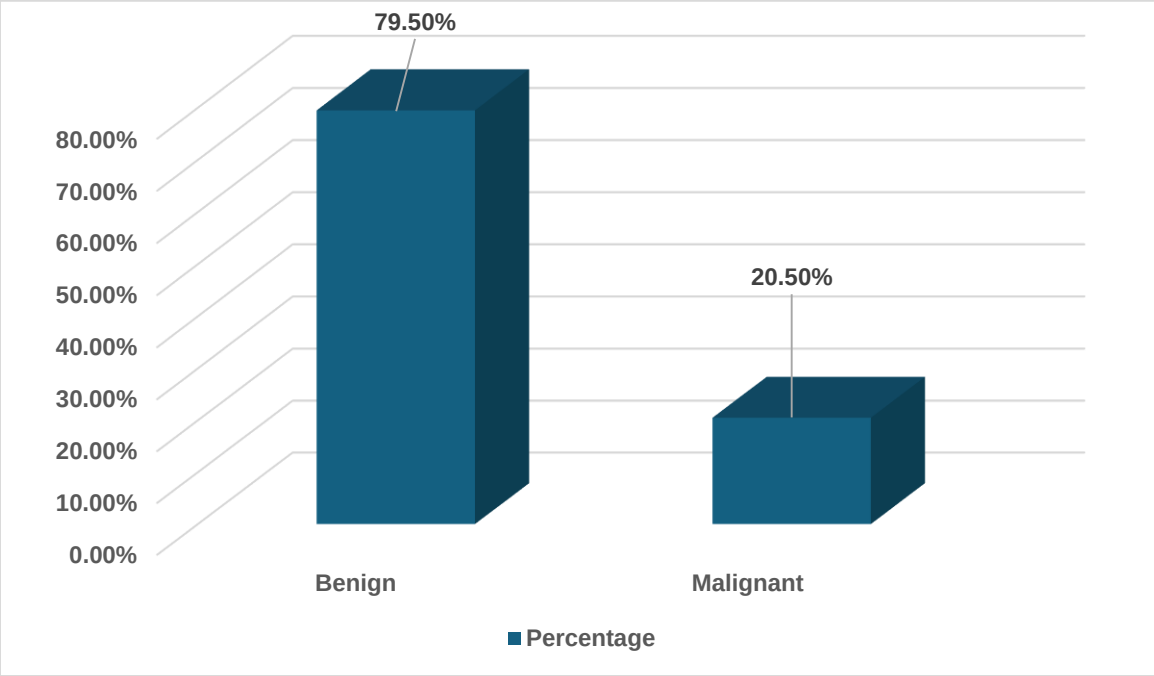
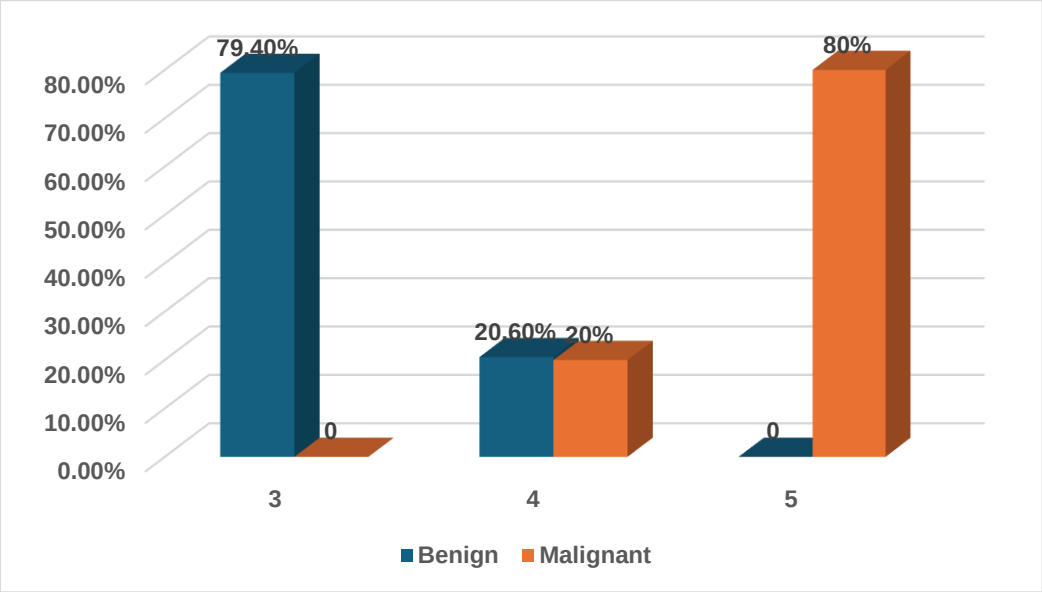


Table 12: Association of type of lesion with ORDAS score

ORADS score		Benign	Malignant	p-value
USG	3	27 (79.4%)	0	<0.001
	4	7 (20.6%)	2 (20%)	
	5	0	8 (80%)	
MRI	3	28 (82.4%)	0	<0.001
	4	6 (17.6%)	2 (20%)	
	5	0	8 (80%)	

Table 12 and graph 9 demonstrates the association between O-RADS scores and final histopathological diagnosis. For both USG and MRI, all lesions classified as O-RADS 3 were benign (76.5% of all benign lesions), while most lesions classified as O-RADS 5 were malignant (80% of all malignant lesions). O-RADS 4 lesions included both benign and malignant pathologies. The association between O-RADS score and malignancy was statistically significant ($p<0.001$) for both imaging modalities, validating the clinical utility of the O-RADS classification system.

Graph 9A: Association of type of lesion with USG ORDAS score



Graph 9B: Association of type of lesion with MRI ORDAS score

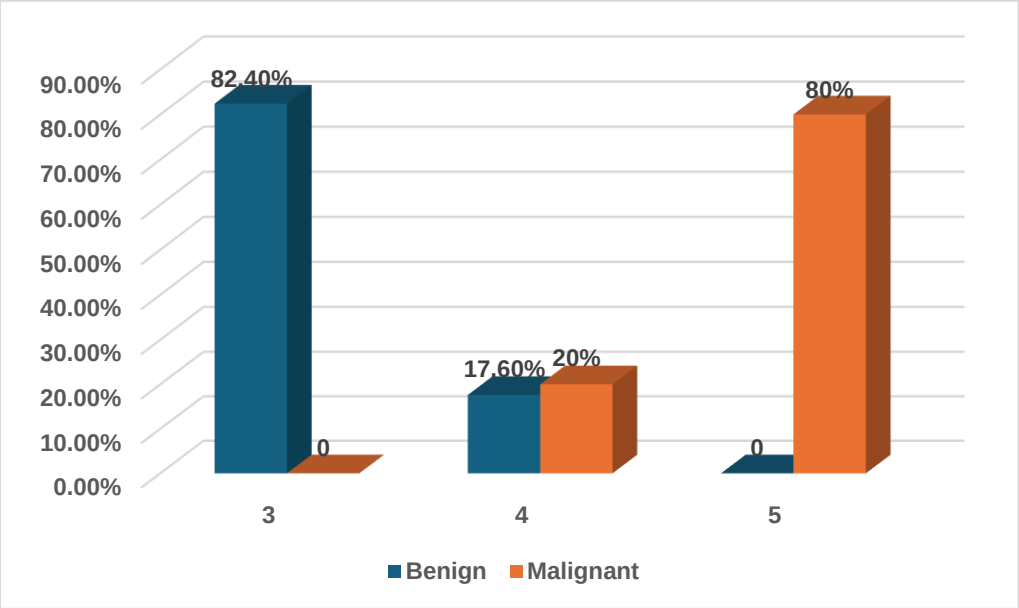


Table 13: Sensitivity analysis of USG and MRI

Sensitivity analysis	USG	MRI
Sensitivity	100%	100%
Specificity	95%	95%
PPV	98%	98%
NPV	97%	97%

Table 10 presents the diagnostic performance metrics of USG and MRI. Both modalities demonstrated identical excellent performance with 100% sensitivity, 95% specificity, 98% positive predictive value, and 97% negative predictive value. These results suggest that both USG and MRI are highly accurate in differentiating benign from malignant ovarian lesions when using the O-RADS system, with no significant difference in diagnostic performance between the two modalities.

DISCUSSION

Ovarian lesions represent a significant diagnostic challenge in gynecological imaging due to their diverse pathological nature and clinical presentations. The accurate characterization of ovarian masses is crucial for appropriate clinical management, as it directly influences the decision between conservative follow-up, medical management, or surgical intervention. The Ovarian-Adnexal Reporting and Data System (O-RADS) has emerged as a standardized risk stratification and management system aimed at improving the diagnostic accuracy and clinical management of ovarian-adnexal pathologies. “This study was undertaken to compare the diagnostic performance of ultrasonography (USG) and magnetic resonance imaging (MRI) in the evaluation of ovarian lesions using the O-RADS classification system”. By analyzing the concordance between these imaging modalities and correlating them with histopathological findings, this study provides valuable insights into the optimal imaging approach for characterizing ovarian lesions in clinical practice. The discussion that follows elaborates on our findings in the context of existing literature, highlighting the implications for clinical practice and potential directions for future research.

Age Distribution and Clinical Presentation

In our study, the majority of patients (65.9%) with ovarian lesions were in the reproductive age group of 21-40 years, which is consistent with findings from similar studies. Foti et al. reported that ovarian neoplasms predominantly affect women of reproductive age, with peak incidence occurring between 20-40 years.[88] This age distribution reflects the hormonal influence on ovarian pathology, with functional cysts and benign neoplasms being more common during the reproductive years. The relatively lower prevalence in post-menopausal women (11.4% in our study) aligns with epidemiological data suggesting that while overall incidence decreases after menopause, the proportion of malignant lesions increases in this age group.[89]

The clinical presentation in our study was dominated by abdominal pain (90.9%), with other symptoms like abdominal mass, back pain, and amenorrhea being relatively uncommon. This predominance of pain as the primary symptom is supported by Timmerman et al., who found that 85-90% of patients with ovarian pathologies initially present with abdominal or pelvic pain.[90]The pathophysiology of pain in ovarian lesions is multifactorial, including mass effect, capsular distension, torsion, rupture, or inflammatory processes. Interestingly, some studies have reported a higher incidence of asymptomatic ovarian masses detected incidentally

during routine examinations. For instance, Levine et al. found that up to 18% of premenopausal women had incidentally detected ovarian cysts on imaging.[91] The higher proportion of symptomatic patients in our study may reflect a referral bias, as our institution is a tertiary care center where patients typically present after developing symptoms.

Laterality and Size of Ovarian Lesions

Our findings revealed a slight predilection for right-sided ovarian lesions (52.3%) compared to left-sided (40.9%) and bilateral (6.8%) lesions. This right-sided predominance, though modest, is consistent with observations by Minaretzis et al., who reported a similar distribution (54% right, 38% left, 8% bilateral) in their series of 246 ovarian masses.[92] The biological basis for this laterality preference remains unclear, although some authors have suggested anatomical differences in venous drainage patterns between the right and left ovaries as a potential contributing factor.

The mean size of ovarian lesions in our study was 117.7 mm (±22.8 mm), indicating that most lesions were relatively large at the time of detection. This finding is comparable to the study by Javadi et al., who reported a mean diameter of 105.3 mm for ovarian masses in their series.[93] The relatively large size at presentation may be attributed to the expandable nature of the pelvic cavity, which

allows ovarian masses to grow considerably before causing symptoms. However, it is noteworthy that lesion size alone has limited value as a predictor of malignancy. Several studies, including that by Valentin et al., have demonstrated that while very large lesions (>10 cm) warrant careful evaluation, size alone cannot reliably differentiate between benign and malignant pathologies.[94]

Imaging Characteristics and O-RADS Classification

Our study showed excellent concordance between USG and MRI in characterizing ovarian lesion morphology, with identical proportions of various lesion types identified by both modalities. Multilocular cystic lesions without solid components were the most common (29.5%), followed by unilocular cystic lesions without solid components (22.7%), solid lesions (18.2%), unilocular cystic with solid components (18.2%), and multilocular cystic with solid components (11.4%).

This morphological distribution is similar to findings reported by Thomassin-Naggara et al., who found that multilocular cystic lesions constituted about 31% of ovarian masses in their prospective multicenter study.[95] The morphological characterization of ovarian lesions forms the cornerstone of the O-RADS classification system, which incorporates features like solid components, papillary projections, septations, and wall irregularity to stratify the risk of malignancy.

The distribution of O-RADS scores in our study was comparable between USG and MRI, with most lesions classified as O-RADS 3 (61.4% on USG and 63.6% on MRI), followed by O-RADS 4 (20.5% on USG and 18.2% on MRI) and O-RADS 5 (18.2% on both USG and MRI). This distribution reflects the spectrum of ovarian pathologies encountered in clinical practice, with intermediate-risk lesions (O-RADS 3) constituting the majority.

Our findings are supported by the work of "Andreotti et al., who evaluated the O-RADS classification in a multicenter study of 1,194 ovarian masses and reported a similar distribution of O-RADS scores (O-RADS 3: 58.7%, O-RADS 4: 23.1%, O-RADS 5: 18.2%)".[96] The slight differences may be attributed to variations in study populations and referral patterns.

Histopathological Correlation and Diagnostic Performance

The histopathological profile in our study revealed a diverse spectrum of ovarian pathologies, with serous cystadenoma (22.7%) being the most common benign diagnosis, followed by mucinous cystadenoma (13.6%), hemorrhagic cysts and fibromas (each 11.4%). Among malignant lesions, serous cystadenocarcinoma and mucinous cystadenocarcinoma were equally common (6.8% each). This distribution is largely consistent with the established epidemiology of ovarian

neoplasms. Forstner et al. reported similar findings in their series of 543 ovarian masses, with serous cystadenomas accounting for 25% of benign lesions and serous cystadenocarcinomas representing the most common malignant epithelial neoplasm.[97]

The overall benign-to-malignant ratio in our study was 79.5% to 20.5%, which aligns with the general understanding that the majority of ovarian masses are benign. This ratio is comparable to that reported by Meys et al. in their systematic review, which found that approximately 8-20% of surgically managed adnexal masses are malignant, depending on the clinical setting and patient demographics.[98]

A critical finding of our study was the significant association between O-RADS scores and final histopathological diagnosis for both USG and MRI ($p<0.001$). All lesions classified as O-RADS 3 were benign, while most lesions classified as O-RADS 5 were malignant (80% of all malignant lesions). O-RADS 4 lesions included both benign and malignant pathologies. This stratification efficacy of the O-RADS system is supported by the original validation studies of the classification.

Amor et al., in their prospective validation of the O-RADS ultrasound risk stratification system, reported malignancy rates of 1.4% for O-RADS 3, 27% for O-

RADS 4, and 85.5% for O-RADS 5 lesions.[99] Similarly, Thomassin-Naggara et al., in their validation of the MRI O-RADS classification, found malignancy rates of 2% for O-RADS 3, 33% for O-RADS 4, and 92% for O-RADS 5 lesions.[100] Our results demonstrate slightly higher specificity for O-RADS 3 (100% benign) and comparable accuracy for O-RADS 5 (80% malignant), affirming the robustness of the classification system in our study population.

Comparative Performance of USG and MRI

One of the primary objectives of our study was to compare the diagnostic performance of USG and MRI in the evaluation of ovarian lesions using the O-RADS system. Both modalities demonstrated identical excellent "performance with 100% sensitivity, 95% specificity, 98% positive predictive value, and 97% negative predictive value". This finding suggests that both USG and MRI are highly accurate in differentiating benign from malignant ovarian lesions when using the O-RADS system, with no significant difference in diagnostic performance between the two modalities.

This equivalent performance is somewhat surprising, as MRI is generally considered superior to USG for tissue characterization due to its multiparametric capabilities. However, our findings are supported by several recent studies that have

highlighted the high diagnostic accuracy of expert-performed ultrasonography in adnexal mass characterization.

Valentini et al. conducted a prospective comparison of USG and MRI for characterizing complex adnexal masses and found comparable overall diagnostic accuracy (USG: 92%, MRI: 93.5%) when performed by experienced radiologists.[101] This suggest that while MRI offers theoretical advantages in tissue characterization, the practical difference in diagnostic performance may be minimal in the hands of experienced operators using standardized reporting systems like O-RADS.

However, it is important to note that the equivalent performance observed in our study should be interpreted within the context of our specific study population and setting. Other studies have identified scenarios where MRI may offer distinct advantages. For instance, Foti et al. found that MRI was particularly valuable for characterizing endometriomas, teratomas, and fibromas, where specific signal characteristics on T1-weighted, T2-weighted, and diffusion-weighted images can provide definitive diagnosis.[102] Additionally, MRI has been shown to be superior for evaluating extensive pelvic disease, assessing local invasion, and planning surgical approaches in cases of suspected malignancy.

Clinical Implications and Practical Considerations

The findings of our study have several important clinical implications. First, they validate the O-RADS classification as a reliable risk stratification tool for ovarian lesions, with excellent correlation between imaging assessment and histopathological outcomes. The high sensitivity and specificity achieved with both USG and MRI suggest that the O-RADS approach can effectively guide clinical management decisions.

Second, the comparable performance of USG and MRI in our study supports the use of ultrasonography as the primary imaging modality for evaluating ovarian lesions, considering its wide availability, lower cost, and absence of radiation. This aligns with current clinical guidelines, including those by the American College of Radiology and the European Society of Urogenital Radiology, which recommend ultrasonography as the first-line imaging modality for adnexal masses.[103,104]

The role of MRI, based on our findings, may be most valuable in specific clinical scenarios rather than as a routine addition to ultrasound evaluation. These **scenarios include:**

1. Indeterminate lesions on USG (particularly O-RADS 4 lesions, which demonstrated overlap between benign and malignant pathologies)

2. Technically limited ultrasound examinations (e.g., in obese patients or those with bowel gas obscuring the adnexa)
3. Detailed pre-surgical mapping in cases of confirmed or highly suspected malignancy
4. Characterization of specific pathologies where MRI offers distinct advantages (e.g., endometriomas, mature teratomas)

This selective approach to MRI utilization is supported by Nougaret et al., who proposed a triage system where MRI is reserved for cases where ultrasound findings are inconclusive or where additional information would impact management decisions.[105] Such an approach optimizes resource utilization while maintaining diagnostic accuracy.

Furthermore, our findings underscore the value of standardized reporting systems like O-RADS in improving communication between radiologists and clinicians and facilitating evidence-based management decisions. The high concordance between USG and MRI O-RADS scores in our study suggests that these modalities can be used interchangeably or complementarily within the framework of the classification system.

Strengths and Limitations

Strengths

Our study has several strengths that enhance the validity and applicability of our findings:

1. Standardized approach: By utilizing the O-RADS classification for both USG and MRI, we ensured a systematic and comparable assessment of ovarian lesions across modalities.
2. Histopathological correlation: All imaging findings were correlated with histopathological diagnoses, providing a definitive reference standard for assessing diagnostic accuracy.
3. Comprehensive morphological assessment: The detailed characterization of lesion morphology (unilocular/multilocular, cystic/solid components) provides valuable insights into the specific imaging features associated with various ovarian pathologies.
4. Clinical relevance: The study addresses a common clinical challenge (evaluation of ovarian lesions) and provides evidence to guide imaging approach in real-world practice.

Limitations

Several limitations should be considered when interpreting our results:

1. Sample size: With 44 patients, our study has a relatively small sample size, which may limit the statistical power for subgroup analyses and the detection of small differences in diagnostic performance between imaging modalities.
2. Single-center design: As a single-institution study, our findings may be influenced by local practices, referral patterns, and the specific expertise of our radiologists, potentially limiting generalizability.
3. Selection bias: Our study included only patients who underwent surgical management with histopathological confirmation, potentially overrepresenting lesions with suspicious imaging features and excluding conservatively managed benign lesions.
4. Observer variability: The study does not address inter-observer variability in the application of O-RADS criteria, which has been identified as a potential limitation of the classification system in previous studies.
5. Technical factors: Variations in ultrasound equipment, MRI protocols, and reader experience may influence diagnostic performance and should be considered when comparing our results to those of other studies.

Future Directions

Our study findings, along with the existing literature, suggest several promising directions for future research:

1. Multicenter validation studies: Larger, multicenter studies are needed to validate the comparable performance of USG and MRI across diverse clinical settings, equipment, and reader expertise.
2. Cost-effectiveness analyses: Formal evaluations of the cost-effectiveness of different imaging strategies (USG alone, MRI alone, or sequential/combined approaches) would provide valuable guidance for resource allocation in healthcare systems.
3. Integration of novel biomarkers: Future research should explore the added value of combining imaging findings with serum biomarkers (e.g., CA-125, HE4) and clinical parameters in comprehensive risk prediction models.
4. Artificial intelligence applications: The development and validation of machine learning algorithms for automated lesion characterization and risk stratification represent an exciting frontier that could potentially improve diagnostic accuracy and standardization.
5. Patient-reported outcomes: Studies examining patient preferences, anxiety, and quality of life associated with different imaging approaches would

provide a more comprehensive understanding of the overall impact of diagnostic strategies.

CONCLUSION

The present study comparing magnetic resonance imaging and ultrasonography in the evaluation of ovarian lesions using the Ovarian-Adnexal Reporting and Data System (O-RADS) has yielded several important conclusions that have significant implications for clinical practice.

Our findings demonstrate that both ultrasonography and magnetic resonance imaging provide excellent diagnostic accuracy in the assessment of ovarian lesions when utilizing the O-RADS classification system. The identical sensitivity (100%), specificity (95%), positive predictive value (98%), and negative predictive value (97%) achieved by both modalities suggest that they are equally effective in differentiating benign from malignant ovarian pathologies. This challenges the common assumption that MRI necessarily offers superior diagnostic performance compared to ultrasonography for ovarian lesion characterization.

The strong correlation between O-RADS scores and final histopathological outcomes validates the clinical utility of this classification system as a risk stratification tool. The finding that all lesions classified as O-RADS 3 were benign, while the majority of O-RADS 5 lesions were malignant, supports the use of O-RADS as a reliable guide for clinical decision-making. The

intermediate category of O-RADS 4, which included both benign and malignant pathologies, highlights an area where clinical judgment and potentially additional diagnostic tools may be beneficial.

The perfect concordance between USG and MRI in characterizing lesion morphology (unilocular/multilocular, cystic/solid components) demonstrates that well-performed ultrasonography can provide detailed morphological assessment comparable to that of MRI. This supports the continued use of ultrasonography as the primary imaging modality for initial evaluation of ovarian lesions, considering its wide availability, lower cost, and absence of radiation or contrast media risks.

While our study showed equivalent overall performance between USG and MRI, the literature suggests that MRI may offer specific advantages in certain clinical scenarios, including characterization of endometriomas, mature teratomas, and fibromas, evaluation of extensive pelvic disease, and pre-surgical mapping in cases of suspected malignancy. Therefore, a selective approach to MRI utilization, where it is reserved for cases where ultrasound findings are inconclusive or where additional information would impact management decisions, appears to be the most rational and cost-effective strategy.

In conclusion, our study supports a tiered approach to imaging of ovarian lesions, with ultrasonography serving as the first-line modality and MRI reserved for specific indications. The O-RADS classification system provides a standardized framework that enhances communication between radiologists and clinicians and facilitates evidence-based management decisions. Future research should focus on refining risk stratification algorithms, exploring the complementary role of serum biomarkers, and developing decision support tools to further improve the diagnosis and management of ovarian pathologies in clinical practice.

SUMMARY

INTRODUCTION

Accurate characterization of ovarian lesions is crucial for appropriate clinical management, as it directly influences the decision between conservative follow-up, medical management, or surgical intervention. The Ovarian-Adnexal Reporting and Data System (O-RADS) has emerged as a standardized risk stratification system aimed at improving diagnostic accuracy and clinical management of ovarian-adnexal pathologies. This study was undertaken to compare the diagnostic performance of ultrasonography (USG) and magnetic resonance imaging (MRI) in the evaluation of ovarian lesions using the O-RADS classification system.

AIMS AND OBJECTIVES

- To evaluate ovarian lesions by ultrasonography and stratify them based on ovarian adnexal reporting and data system.
- To correlate findings of ultrasonography with M.R.I. and assess the accuracy of ovarian adnexal reporting and data system stratification by ultrasonography.

MATERIAL AND METHODS

This prospective observational study was conducted in the Department of Radiodiagnosis at Shri B M Patil Medical College Hospital & Research Centre, Vijayapura from April 2023 to April 2025. A total of 44 patients with clinically suspected ovarian lesions who underwent both USG and MRI followed by histopathological confirmation were included. Lesions were characterized according to the O-RADS classification on both modalities, and the findings were correlated with histopathological results. “Statistical analysis was performed to determine sensitivity, specificity, positive predictive value, and negative predictive value of both imaging modalities”.

RESULTS

The key findings of the study are summarized as follows:

- Demographic and Clinical Profile: The majority of patients (65.9%) were in the 21-40 years age group, with abdominal pain being the predominant clinical presentation (90.9%). Right-sided lesions (52.3%) were slightly more common than left-sided (40.9%) and bilateral (6.8%) lesions. The mean size of ovarian lesions was 117.7 mm with a standard deviation of 22.8 mm.
- Morphological Characteristics: Both USG and MRI identified identical proportions of various lesion types: multilocular cystic without solid

component (29.5%), unilocular cystic without solid component (22.7%), solid lesions (18.2%), unilocular cystic with solid component (18.2%), and multilocular cystic with solid component (11.4%). This demonstrated perfect concordance between the two modalities in characterizing ovarian lesion morphology.

- O-RADS Classification: The distribution of O-RADS scores was similar between both modalities, with most lesions classified as O-RADS 3 (61.4% on USG and 63.6% on MRI), followed by O-RADS 4 (20.5% on USG and 18.2% on MRI) and O-RADS 5 (18.2% on both USG and MRI).
- Histopathological Correlation: The histopathological profile revealed a diverse spectrum of ovarian pathologies, with serous cystadenoma (22.7%) being the most common benign diagnosis, followed by mucinous cystadenoma (13.6%), and hemorrhagic cyst and fibroma (each 11.4%). Among malignant lesions, serous cystadenocarcinoma and mucinous cystadenocarcinoma were equally common (6.8% each). The overall benign-to-malignant ratio was 79.5% to 20.5%.
- Association with O-RADS Score: A significant association was found between O-RADS scores and final histopathological diagnosis for both USG and MRI ($p<0.001$). All lesions classified as O-RADS 3 were benign, while

most lesions classified as O-RADS 5 were malignant (80% of all malignant lesions). O-RADS 4 lesions included both benign and malignant pathologies.

- Diagnostic Performance: Both USG and MRI demonstrated identical excellent “performance with 100% sensitivity, 95% specificity, 98% positive predictive value, and 97% negative predictive value”. This indicates that both modalities are highly accurate in differentiating benign from malignant ovarian lesions when using the O-RADS system.

These findings suggest that while both imaging modalities offer excellent diagnostic performance, ultrasonography should remain the primary imaging approach for initial assessment of ovarian lesions due to its wide availability, lower cost, and absence of radiation or contrast media risks. MRI may be reserved for specific scenarios where it offers distinct advantages, such as inconclusive ultrasound findings, technically limited examinations, or pre-surgical mapping in cases of confirmed or highly suspected malignancy.

CONCLUSION:

Both ultrasonography and magnetic resonance imaging, when utilized within the framework of the O-RADS classification system, provide excellent and comparable diagnostic accuracy in the evaluation of ovarian lesions. The

significant association between O-RADS scores and histopathological outcomes validates the clinical utility of this classification system for risk stratification and management planning. A tiered imaging approach, with ultrasonography as the first-line modality and MRI reserved for specific indications, appears to be the most rational and cost-effective strategy for evaluating ovarian lesions.

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BLDE

(DEEMED TO BE UNIVERSITY)

Declared as Deemed to be University u/s 3 of UGC Act, 1956

Accredited with 'A' Grade by NAAC (Cycle-2)

The Constituent College

SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

BLDE (DU)/IEC/ 944/2023-24 10/4/2023

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this University met on **Saturday, 18th March, 2023 at 11.30 a.m. in the CAL Laboratory, Dept. of Pharmacology,** scrutinized the Synopsis/ Research Projects of Post Graduate Student / Under Graduate Student /Faculty members of this University /Ph.D. Student College from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

TITLE: "COMPARISON STUDY OF MAGNETIC RESONANCE IMAGING AND ULTRASONOGRAPHY IN EVALUATION OF OVARIAN LESIONS WITH EMPHASIS ON OVARIAN ADNEXAL REPORTING AND DATA SYSTEM".

NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: DR.NALLURI SIDDHARTHA

NAME OF THE GUIDE: DR.RAJASHEKHAR MUCHCHANDI, PROFESSOR AND HEAD, DEPT. OF RADIODIAGNOSIS.

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA

Chairman,
Institutional Ethical Committee,
BLDE (Deemed to be University)
Vijayapura

Dr.Akram A. Naikwadi
Member Secretary
IEC, BLDE (DU),
VIJAYAPURA

MEMBER SECRETARY
Institutional Ethics Committee
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Vijayapura-586103. Karnataka

Following documents were placed before Ethical Committee for Scrutinization.

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

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CASE SHEET PROFORMA

NAME:

AGE:

SEX:

IP/OP NO:

CHIEF COMPLAINTS:

DETAILED HISTORY:

RELEVANT CLINICAL EXAMINATION FINDINGS:

GENERAL EXAMINATION:

PER ABDOMINAL EXAMINATION:

PER SPECULUM EXAMINATION:

BIMANUAL EXAMINATION:

PROVISIONAL CLINICAL DIAGNOSIS:

RADIOLOGICAL FINDINGS:

USG FINDINGS –

Characteristics	Yes	no
Size cm		
Well defined / regular margin		
Wall thickness > 3mm		
Bilaterality		
Cystic		
Multilocularity		
Solid components within		
Solid mass with cystic components/necrotic areas		
Septa (if yes, fine or thick)		
Vascularity		
High resistance flow on Doppler		
POD fluid		
Ascites		

MRI FINDINGS –

Characteristics	Yes	no
Size > 5 cm		
Well defined / regular margin		
Wall thickness > 3mm		
Bilaterality		
Cystic		
Multilocularity		
Solid components within		
Solid mass with cystic components/necrotic areas		
Septa (if yes, fine or thick)		
Enhancement pattern opcs		
Ascites		
Local / regional invasion		
Lymph nodes involvement		

FINAL DIAGNOSIS:

HPR REPORT:

CONSENT FORM

TITLE OF RESEARCH: COMPARISON STUDY OF MAGNETIC RESONANCE IMAGING AND ULTRASONOGRAPHY IN EVALUATION OF OVARIAN LESIONS WITH EMPHASIS ON OVARIAN ADNEXAL REPORTING AND DATA SYSTEM

GUIDE: DR. SATISH D PATIL

P.G. STUDENT: DR. NALLURI SIDDHARTHA

PURPOSE OF RESEARCH:

I have been informed that the purpose of this study is to evaluate the correlation of USG to the MRI findings in patients with ovarian lesions.

I understand that I will undergo detailed history and clinical examination and investigations.

RISKS AND DISCOMFORTS:

There is no risk involved .

BENEFITS:

I understand that my participation in this study will help in determining role of USG & MRI in evaluation of ovaria lesions.

Institutional protocols can be set up for imaging of ovarian lesions.

CONFIDENTIALITY:

The medical information produced by the study will become a part of hospital record and will be subjected to confidentiality and privacy regulations of hospital. When the data is used for publications the identity of the patient will not be revealed.

REQUEST FOR MORE INFORMATION:

I understand that I may be asked for more information about the study at any time.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I/my ward understand that my participation is voluntary and I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital.

I/my ward also understand that Dr. Nalluri Siddhartha will terminate my participation in this study at any time after he has explained the reasons for doing so and has helped arrange for my continued care by my own physician or therapist, if this is appropriate

INJURY STATEMENT:

I understand that in the unlikely event of injury to me/my ward, resulting directly to my participation in this study, if such injury were reported promptly, then medical treatment would be available to me, but no further compensation will be provided.

I understand that by my agreement to participate in this study, I am not waiving any of my legal rights.

I have explained to _____ the purpose of this research, the procedures required and the possible risks and benefits, to the best of my ability in patient's own language.

Date:

Dr. SATISH D PATIL (Guide)

Dr Siddhartha (Investigator)

STUDY SUBJECT CONSENT STATEMENT:

I/my ward confirm that Dr.Shantala has explained to me the purpose of this research, the study procedure that I will undergo and the possible discomforts and benefits that I may experience, in my own language.

I/my ward have been explained all the above in detail in my own language and I understand the same. Therefore I agree to give my consent to participate as a subject in this project.

_____ _____

(Participant) Date

_____ _____

(Witness to above signature) Date

CASE REPORTS

Case 1:Mucinous Cystadenoma-

A 37 year old female with complaints of pain the abdomen from 20 days

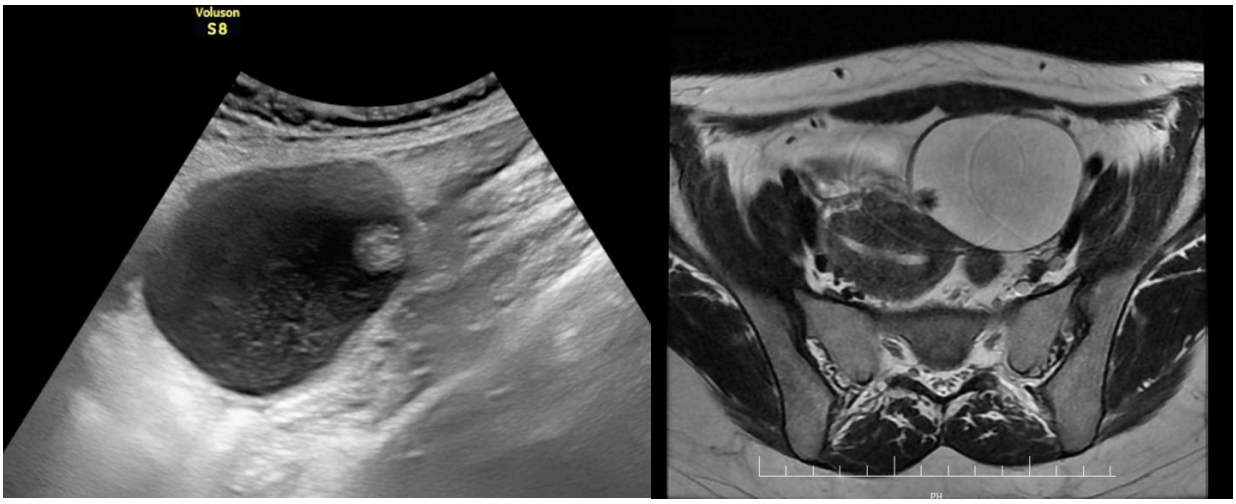

Figure 20

USG: A well defined unilocular non simple cyst with a mural nodule measuring 7 x 5 cm is noted arising from the right ovary, the mural nodule is showing minimal vascularity on color doppler

- S/o ORADS 4(Intermediate risk)

MRI: A well defined unilocular cystic lesion(T1 hypointense and T2 hyperintense) lesion measuring 7 x 5 cm arising from right ovary- ORADS-4

Case 2:Mature Teratoma

A 42 year old female patient came with complaints of pain abdomen from one month

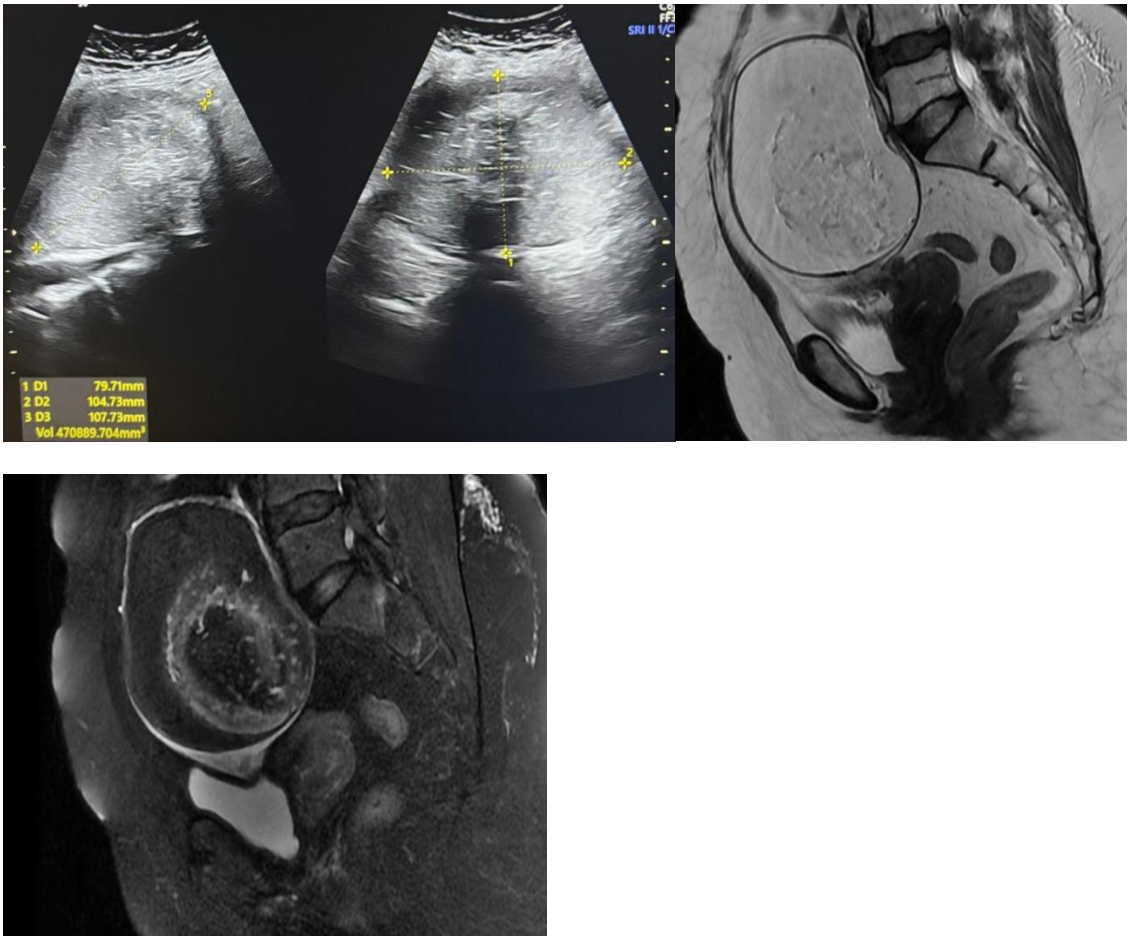

Figure 21

USG: A well defined hyperechoic lesion with hyperechoic lines and dots with no flow on color doppler measuring 104 x 79 x 107 mm is noted arising from the left ovay- S/o ORADS-3 lesion(Low risk).

MRI:A well defined T1 and T2 hyperintense lesion and hypointense on FAT_SAT images measuring 11 x 8.8 x 10.6 cm is noted arising from the left ovary, the lesion is showing mass effect on the adjacent urinary bladder and bowel.

Case 3:serous cystadenoma

A 35 year old female patient came with complaints of back ache and amenorrhea from past two months

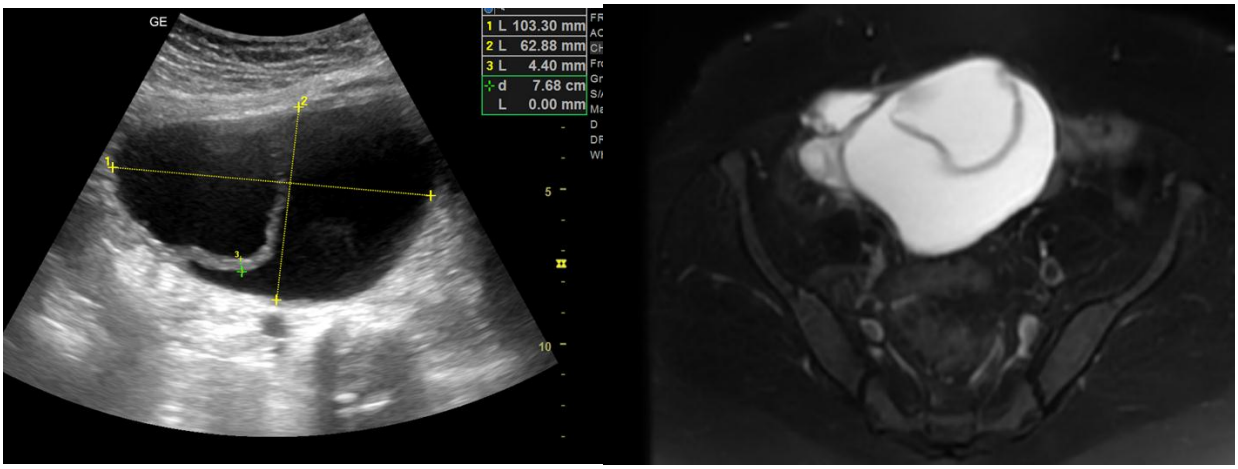

Figure 22

USG:A well defined bilocular cystic lesion measuring 6.2 x 5 x 6 cm is noted arising from right ovary with thick septation- ORADS-3

MRI: A well defined bilocular cystic lesion measuring 7 x 5 x 6 cm is noted arising from the right ovary with a thick septation within- ORADS-3

Case 4:Mucinous Cystadenoma

A 55 year old female patient came with complaints of pain in abdomen since 15 days.

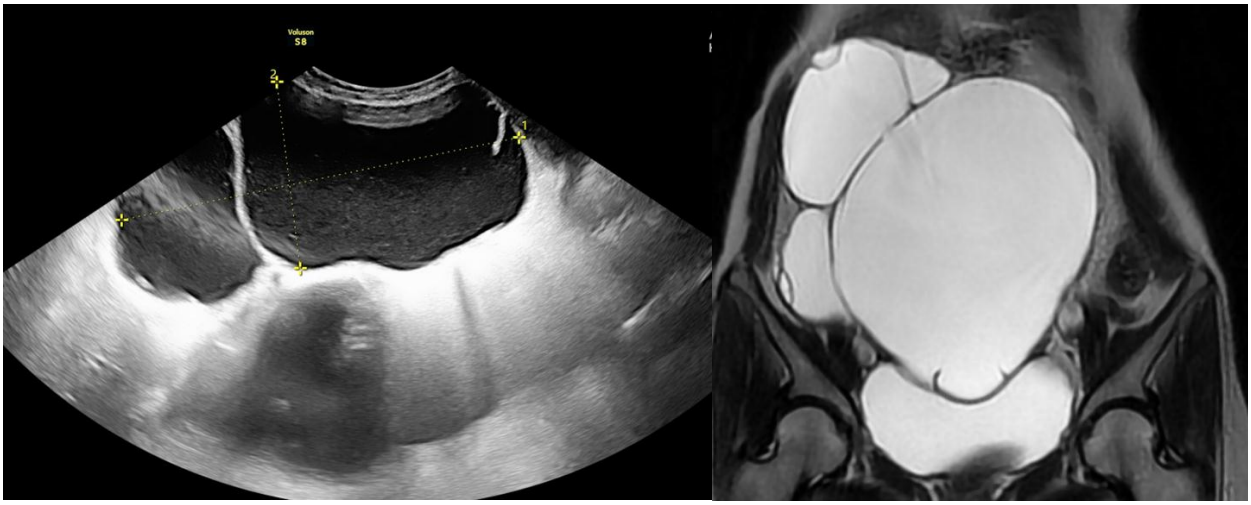

Figure 23

USG:A well defined multilocular cystic lesion with smooth inner margins measuring 13 x 8 x 11 cm is noted in the right adnexa with minimal color flow on doppler- ORADS-4

MRI: A well defined multilocular cystic lesion with smooth inner margines measuring 13 x 8 x12 cm is noted in the right adnexa- ORADS-4

Case 5:Fibroma

A 33 year old female patient came with complaints of pain in abdomen since one week.

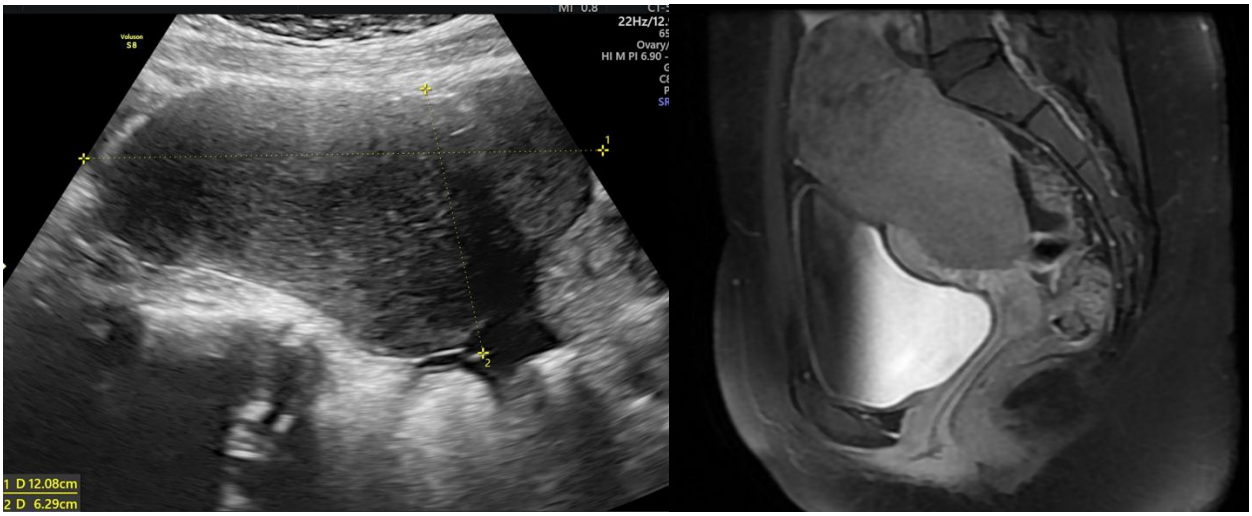

Figure 24

USG:A well defined hypoechoic solid lesion with smooth margins measuring 12 x 6 cm is noted arising from the left ovary with no flow on color doppler- S/oORADS-3

MRI:A well defined solid T1 and T2 hypointense lesion with smooth margins measuring 12 x 6 cm is noted arising from the left ovary- S/o ORADS-3

Case 6:Mucinous Cystadenoma

A 27 year old female came with complaints of pain in abdomen and amenorrhea since 2 months.

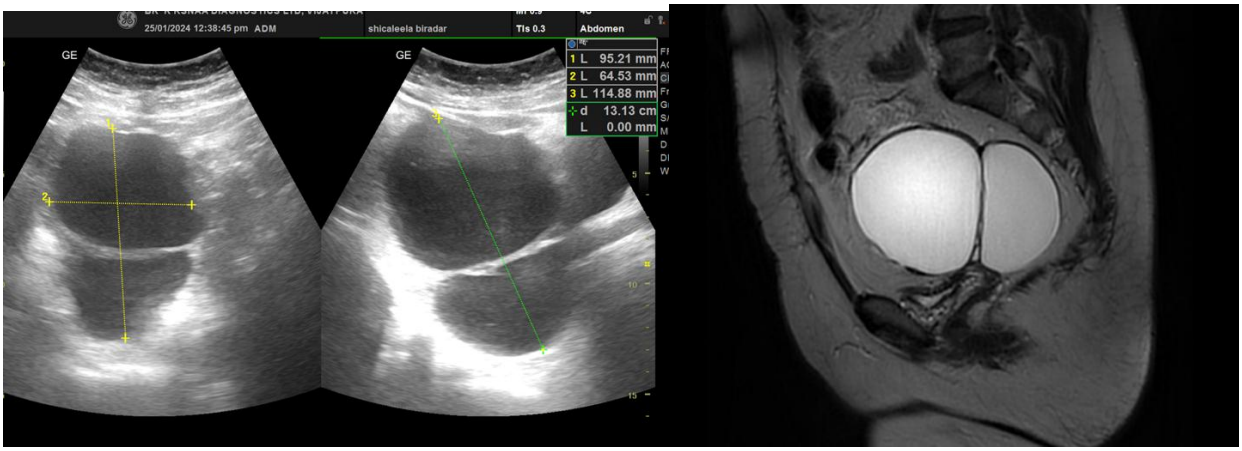

Figure 25

USG:A well defined bilocular cystic lesion measuring 11 x 6.4 x 9.5 cm is noted arising from right ovary with no flow on color doppler- ORADS-3

MRI: A well defined bilocular cystic lesion measuring 11 x 6.4 x 9.5 cm is noted arising from the right ovary - ORADS-3

Case 7: Endometroid adenocarcinoma

A 21 year old female came with complaints of pain in abdomen and back ache.

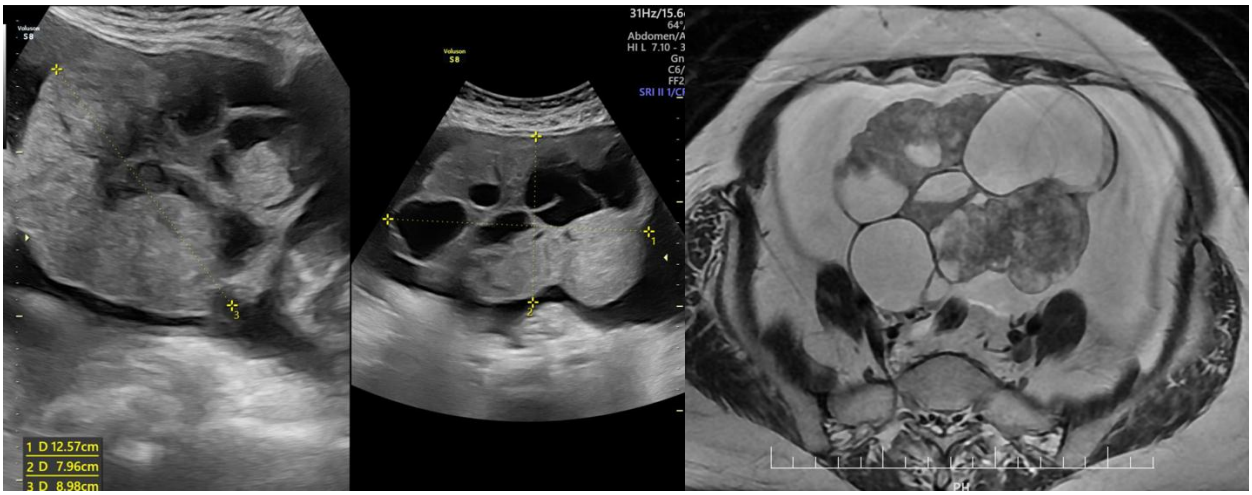

Figure 26

USG: An ill defined solid lesion with cystic component is noted in the left adnexa measuring 12 x 8 x 9 cm showing moderate flow on color doppler – ORADS-5

MRI: An ill defined solid lesion with cystic component is noted in the left adnexa measuring 12 x 8 x 9 cm showing enhancement on post contras t– ORADS-5

Case 8:Mucinous cystadenocarcinoma

A 53 old female came with complaints of pain in abdomen since 1 month.

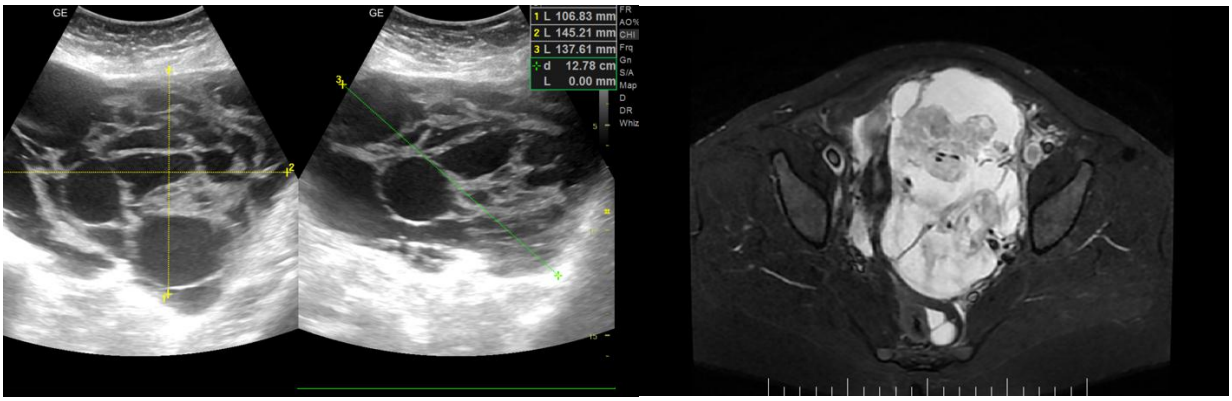

Figure 27

USG:A well defined multilocular cystic lesion with solid component measuring 14 x 13.7 x 10 cm is noted in the left adnexa with minimal color flow on doppler- ORADS-5

MRI: A well defined multilocular cystic lesion with solid component measuring 14 x 13.7 x 10 cm is noted in the right adnexa, the solid component is showing diffusion restriction- ORADS-5