Section A -Research paper

Evaluation of Adenexal Masses Using Gynecology Imaging Reporting and Data System (GI-RADS) In Comparison With Risk of Malignancy Index

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Abstract:

Background: Ovarian cancer is the fourth cause of death from cancer in women worldwide. The differentiation of benign from malignant adnexal masses is of great therapeutic significance. Hence, the pre-operative detection of the nature of adnexal mass becomes extremely important for appropriate management. Screening and diagnostic methods for ovarian cancer include pelvic examination, cancer antigen 125 (CA 125) as a tumor marker, transvaginal ultrasound (TVS), and potentially multimarker panels and bioinformatic analysis of proteomic patterns. **Aim:** Compared the diagnostic performance of the Gynecology Imaging Reporting and Data System (GI-RADS) and the risk of malignancy index (RMI) as regard their ability to evaluate adenexal masses preoperative considering the histopathological definitive diagnosis as the reference. **Patients and Methods:** The current study was Cross sectional Study carried out on 105 women with adnexal masses were recruited from the department of Obstetrics and Gynecology & Radio- diagnosis department, Zagazig University Hospitals. Each case was subjected to ultrasound (transvaginal or transabdominal) using a canon aplio 500 and Morphological features was examined according to GI-RADS, Calculation of RMI & MRI done to all patients. **Results:** Diabetes mellitus & hypertension were among the factors coinciding with development of ovarian malignancy. Seven (14%) of diabetic patients had benign lesions and 19 (34.5%) had malignant lesions. Six (12%) of hypertensive patients had benign masses and 17 (30.9%) had malignant masses. There's statistical significance between medical disorders and malignant masses which were diagnosed by histopathology, P>0.05. Malignant Adenexal masses common in postmenopausal patients, where 38 (76%) of pre-menopausal cases had benign lesions and 33 (60%) of postmenopausal cases had malignant lesions. There's high statistical significance between menopausal status and malignant masses which were diagnosed by histopathology, P≤0.001. **Conclusion:** GI-RADS and RMI classification had good performance in discriminating ovarian tumors.

Keywords: Gynecology imaging reporting, data system, Ca-125, Ultrasound, Ovarian tumor

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Introduction

Ovarian tumors are a common clinical entity that affects women of all ages[(1)]. Ovarian cancer remains the fifth leading cause of cancer-related death[(2,3)]. While the prevalence of adnexal masses is very frequent (up to 20 %), the prevalence of ovarian cancer is low (approximately 0.2-0.3 % in post-menopausal women). Because the patient survival is strongly associated with disease stage, there have been many attempts of early diagnosis[(4,5)].

Although often overlooked, the preoperative characterization of an adnexal mass is of crucial importance for selecting the optimal management strategy. Accurate differentiation between benign and malignant tumors can lead to referral of patients with malignant tumors to gynecological oncology centers for further diagnosis or staging, followed by debulking surgery and/or administration of systemic therapy. This is an important factor that positively influences prognosis[6-8]. Benign ovarian masses can be managed expectantly or by conservative surgical management with reduced morbidity and fertility preservation[9].

Secondly, optimal treatment of adnexal malignancies depends on the type of tumor. Borderline tumors can be treated with less aggressive techniques than invasive tumors, which is of interest when fertility preservation is desired[10,11].

Ultrasonography is currently considered as the primary imaging modality for identifying and characterizing adnexal masses[12]. One of the best methods for discriminating between benign and malignant adnexal masses is subjective assessment; i.e. subjective evaluation of gray-scale and Doppler ultrasound findings by an experienced ultrasound examiner **Van Calster et al**[13]; also called pattern recognition. However, using subjective assessment, a small proportion of masses cannot be confidently classified as benign or malignant ('unclassifiable masses') [14]. For such masses, methods other than subjective assessment are needed such as risk of malignancy index (RMI).

Optimization of the diagnostic performance of transvaginal sonography by creating predictive models with the use of scoring systems, logistic regression analysis, neural networks, and support vector machines has been attempted[15]. In this study we compared the diagnostic performance of the Gynecology Imaging Reporting and Data System (GI-RADS) and the risk of malignancy index (RMI) as regards their ability to preoperatively evaluate adnexal masses considering the histopathological definitive diagnosis as the reference.

Patients and Methods

This Cross sectional Study was carried out at department of Obstetrics and Gynecology & Radiodiagnosis department, Zagazig University Hospitals, from January 2021 to January 2023. Before start the study, permission was obtained from institution review board IRB of faculty of medicine Zagazig University. The procedure presented less than minimal risk for which written consent is not needed so verbal consent only was obtained. But written consent was obtained for surgical interference. The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human testing. The inclusion criteria were primarily based on the clinical diagnosis of an adnexal mass followed by ultrasound confirmation. Patients with pregnancy, Patients with a history of gynecologic or other malignant tumors were excluded from the study.

All patients were subjected to full history taking with special focus on risk factors of ovarian malignancy including age, menopausal status, parity and medical comorbidities as diabetes and hypertension. General, abdominal and Pelvic examination with special focus on malignant criteria e.g

abdominal or pelvic palpable mass and ascitis. Investigations (CBC, liver and kidney function tests, coagulation profile, random blood sugar and urine analysis). Ultrasound (transvaginal or transabdominal) using a canon aplio 500. Trans-vaginal ultrasound was done for all patients using IC 5-9 endovaginal probe on canon aplio 500. Trans-abdominal ultrasonography was done to examine large masses (more than 10 cm) that could not be completely seen by TVS and virgin patients, using AB 2-7 convex abdominal probe.

Morphological features was examined according to GI-RADS which include; Unilateral involvement. The maximum diameter of the lesion. The wall thickness. Septation. Solid papillary projections. Solid areas within the cyst. Cystic content. Ascites. Color.

Doppler was used to assess peripheral or central vascularization. Peripheral blood flow was defined if color signals were seen in the periphery of the mass; while central blood flow was defined if color signals were seen in the central part of the mass, solid areas, septa, or papillary projections If the mass exhibited central and peripheral blood flow, the central blood flow only was used for analysis**.**

Risk of Malignancy Index 1 (RMI 1) was calculated as a product of (U × M × CA 125). Cut off level of 200 was set to differentiate between benign and malignant mass.

All women included in the study underwent surgery for mass removal. Surgery was carried out by laparoscopy or laparotomy, according to the surgeon's judgment, the patient preference and the nature of the lesion. Histopathological examination was reported in all cases and used as the gold standard. Results were compared with final histopathological diagnosis.

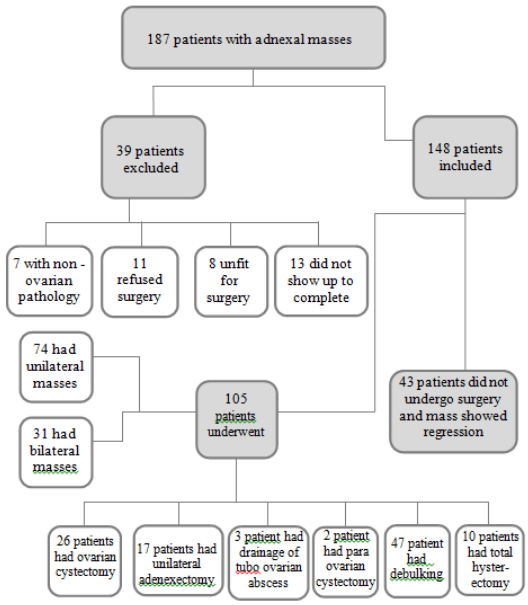
Statistical Analysis:

Data were fed to the computer and analyzed using **IBM SPSS software package version 27.0. (Armonk, NY: IBM Corp)** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean and standard deviation. Significance of the obtained results was judged at the 5% level ($p \leq 0.05$).

Results

This cross-sectional study was conducted at department of Obstetrics and Gynecology & Radiodiagnosis department, Zagazig University Hospitals, from January 2021 to January 2023.

A total of 187 patients with adenexal masses. Seven patients proved to have non-ovarian pathologies by transvaginal ultrasound, 11 refused surgery, 8 were unfit for surgery, and 13 did not complete their investigations. Those 39 patients were excluded. Out of the remaining 148 patients, 43 patients did not undergo surgery and had cysts which showed regression on follow up ultrasound. The remaining 105 patients, with masses eligible for final analysis, underwent surgery and all removed masses were sent for definitive histopathological diagnosis. According to the histopathology of the 105 cases eligible for final analysis, masses were classified as benign and malignant (borderline and malignant).



Flowchart showing patient classification in the study

Table (1): Clinical characteristics of the patients subjected to surgery.

Clinical characteristics		
Age (years)		
Range	15-75	
Mean ± S.D.	47.02 ± 16.79	
BMI(KG/M^2)		
Mean ± S.D.	30.78±6.7	
Parity	**Number n=105**	**Percent**
Multipara	87	82.9%
Nullipara	18	17.1%
Menopausal status		
Pre-menopausal	60	57.14%
Post-menopausal	45	42.86%
Medical disorders		
No medical disorders	56	53.34%
Diabetes	26	24.76%
Hypertension	23	21.9%
bilaterality of the lesion		
Unilateral	74	70.48%
Bilateral	31	29.52%

Table (1) Shows General characteristics of the studied patients where, Age ranged between 15-75 years with mean value 47.02 ± 16.79 years. The mean for the BMI was 30.78±6.7 kg/m2. The number of nulliparous patients was 18(17.1%) while that of multiparous patients was 87 (82.9%). As for the menopausal status, 60 patients were pre-menopausal (57.14%) and 45 patients were post-menopausal (42.86%). According to medical disorders, 56(53.34%) had no chronic illness, 26 (24.76%) had diabetes, 23 (21.9%) had hypertension. According to bilaterality of the lesion 74(70.48%) were unilateral & 31(29.52%) were bilateral.

Table (2): Relation between clinical characteristics and histopathological results in the studied patients.

	Histopathological results		**P value**
	Benign N=50	**Malignant N=55**	
Age			
Mean ± S.D.	40.86±17.51	52.62±14.05	**<0.001****
Parity			
Multipara	38(76%)	49(89.1%)	0.064
Nullipara	12(24%)	6(10.9%)	
BMI (Kg/M^2)			
Mean ± S.D.	29.8±6.7	34.04±5.8	**0.006***
Menopausal status			
Premenopausal	38(76%)	22(40%)	**<0.001****
Postmenopausal	12(24%)	33(60%)	
Medical disorders			
Diabetes	7(14%)	19(34.5%)	**0.023***
Hypertension	6(12%)	17(30.9%)	**0.032***
Bilaterality of Adenexal Masses			
Unilateral	41(82%)	33(60%)	**0. 018***
Bilateral	9(18%)	22(40%)	

Table (2) Shows relation between clinical characteristics and histopathological results in the studied patients. Where The mean Age of patients with benign adenexal masses is 40.86 ± 17.51 years versus 52.62 ± 14.05 years in the patients

with malignant adenexal masses. There's high statistical significance between age of the patients and malignant masses which was diagnosed by histopathology, P≤0.001. According to parity 49 (89.1%) of multipara had malignant lesions and 6 (10.9%) of nullipara had malignant lesions & 38 (76%) of multipara had benign masses and 12 (24%) of nulipara had benign masses. There's no statistical significance between parity and malignant masses which was diagnosed by histopathology, P=0.064. BMI was significantly higher in the patients with malignant lesions 34.04 ± 5.8 kg/m^2 versus 29.8 ± 6.7 kg/m^2 in patients with benign lesions, P=0.006. Thirty eight (76%) of pre-menopausal patients had benign lesions and 33 (60%) of post-menopausal patients had malignant lesions. There's high statistical significance between menopausal status and malignant masses which were diagnosed by histopathology, P≤0.001. According to medical disorders, 7 (14%) of diabetic patients were benign and 19 (34.5%) were malignant. Six (12%) of hypertensive patients had benign masses and 17 (30.9%) had malignant masses. There's statistical significance between medical disorders and malignant masses which were diagnosed by histopathology, P<0.05. Fourty one (55.4%) of unilateral lesions were benign and 22(71%) of bilateral lesions were malignant. There's high statistical significance between bilaterality of the lesion and malignant masses which were diagnosed by histopathology, P=0.018.

Table (3): Distribution of the studied patients according to the Gynecology Imaging Reporting and Data System (GI-RADS).

GI-RADS	Number	Percent
2	2	1.90
3	30	28.57
4	41	39.05
5	32	30.48
Total	105	100

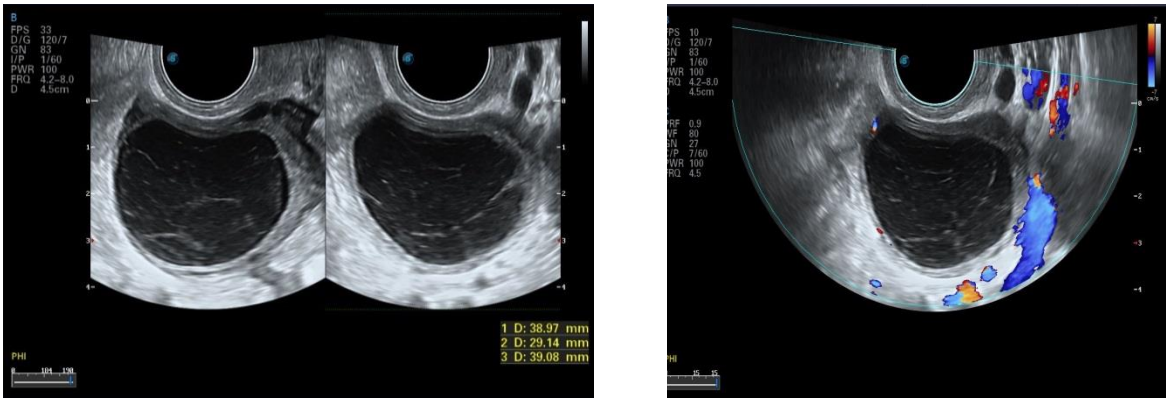
Table (3) shows distribution of the studied sample according to GI-RADS. Where 2(1.9%) GI-RADS 2, 30(28.57%) GI-RADS 3, 41(39.05%) GI-RADS 4 and 32(30.48%) GI-RADS 5.

Table (4): Distribution of the studied patients according to histopathological results.

Pathology	Number	Percent
Benign	50	47.62%
Dermoid cyst	13	12.38%
Serous Cystadenoma	12	11.42%
Hemorrhagic cyst	5	4.76%
Mucinous cystadenoma	5	4.76%
Endometrioma	4	3.81%
Fibroma	4	3.81%
Tubo-ovarian abscess	4	3.81%
Paraovarian cyst	2	1.9%
Fibroid	1	0.95%
Malignant	55	52.38%
Serous cystadenocarcinoma	36	34.28
mucinous cystadenocarcinoma	4	3.81
Border line serous cystadenoma	3	2.85
Clear cell carcinoma	3	2.85
Dysgerminoma	3	2.85
Endometrioid adenocarcinoma	1	0.95
Border line mucinous cystadenoma	1	0.95
Granulosa cell tumor	1	0.95
Immature teratoma	1	0.95
Papillary thyroid carcinoma on top of strauma ovarii	1	0.95
Undifferentiated carcinoma	1	0.95
Total	105	100

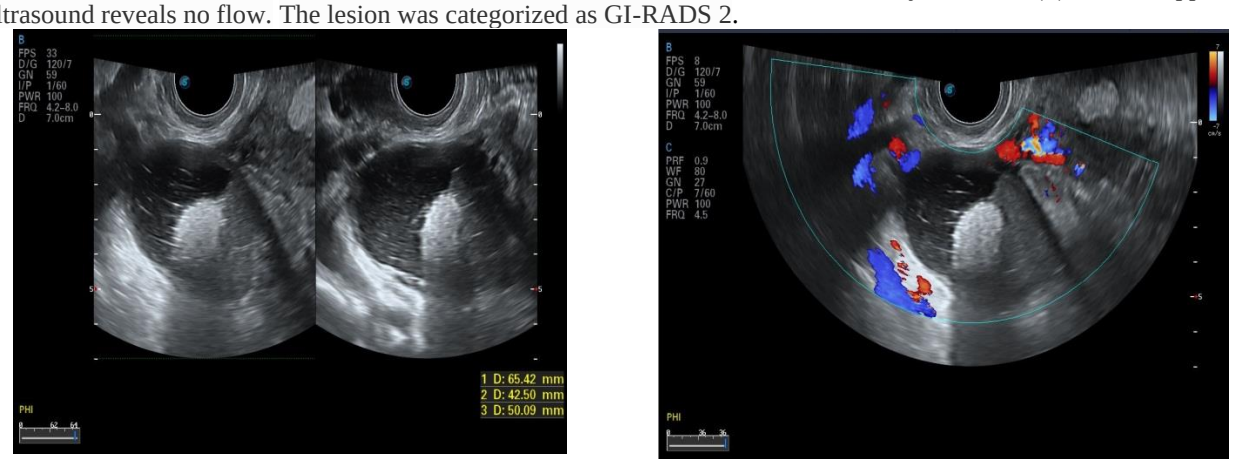
Table (4) shows distribution of the studied patients according to histopathological results where, the benign adnexal masses were 50 (47.62%) and classified as follow: 13 (12.38%) dermoid cysts, 12 (11.42%) serous cystadenoma, 5 (4.76%) hemorrhagic cysts, 5 (4.76%) mucinous cystadenoma, 4 (3.81%) endometrioma, 4 (3.81%) fibroma, 4 (3.81%) tuboovarian abscess, 2 (1.9%) par-ovarian cysts, 1(0.95%) fibroid. The prevelance of malignant masses including borderline masses in this study was 52.38% (55 masses out of 105) , classified as follows: 36 (34.28%) serous

cystadenocarcinoma, 4 (3.81%) mucinous cystadeno- carcinoma, 3 (2.85%) border line serouscystadenoma, (2.85%) clear cell carcinoma, 3 (2.85%) dysgerminoma, 1 (0.95%) endometrioid adeno- carcinoma, 1 (0.95%) border line mucinouscystadenoma, 1 (0.95%) granulosa cell tumour, 1 (0.95%) immature teratoma, 1 (0.95%) papillary thyroid carcinoma on top of strauma ovarii, 1 (0.95%) undifferentiated carcinoma.



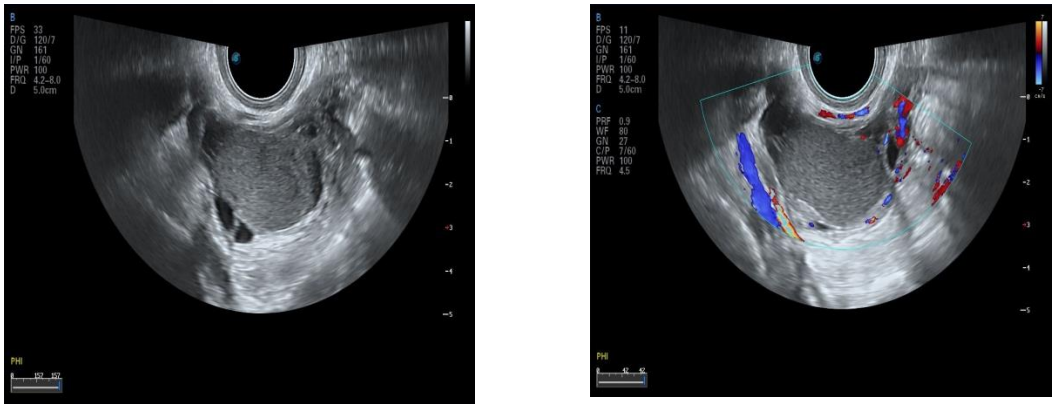
A **B**

(Figure 1): A 27-year-old woman with a pathologically proven hemorhagic cyst. **(a)** a Transvaginal ultrasound reveals a 4cm well-defined cystic mass, there is lace-like reticular echoes within the cystic mass. **(b)** Color Doppler ultrasound reveals no flow. The lesion was categorized as GI-RADS 2.



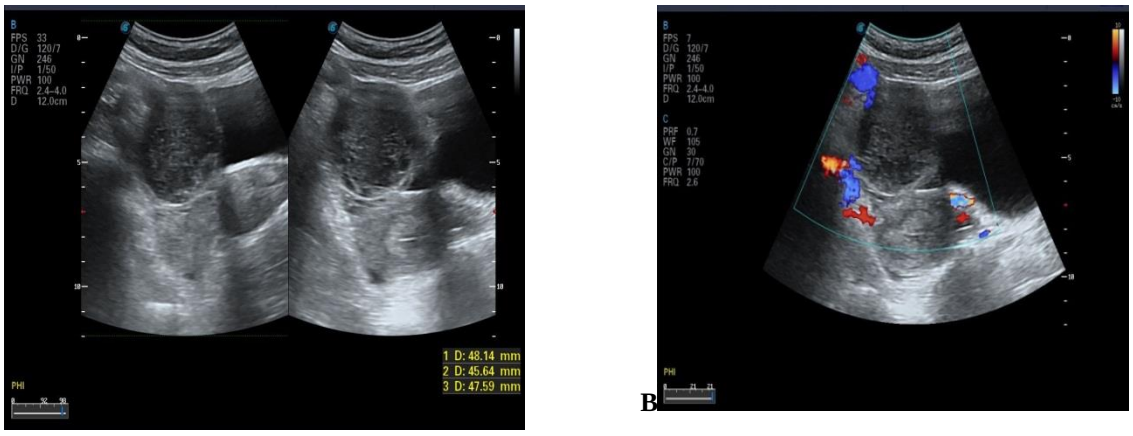
A **B**

(Figure 2): A 39-year-old woman with a pathologically proven dermoid. **(a)** a Transvaginal ultrasound reveals a 6.5cm well-defined cystic mass, there is awell-defined hyperechoic nodule within the cystic mass near cyst wall & fine hyperechoic lines called "dermoid mesh". **(b)** Color Doppler ultrasound reveals no flow. The lesion was categorized as GI-RADS 3.



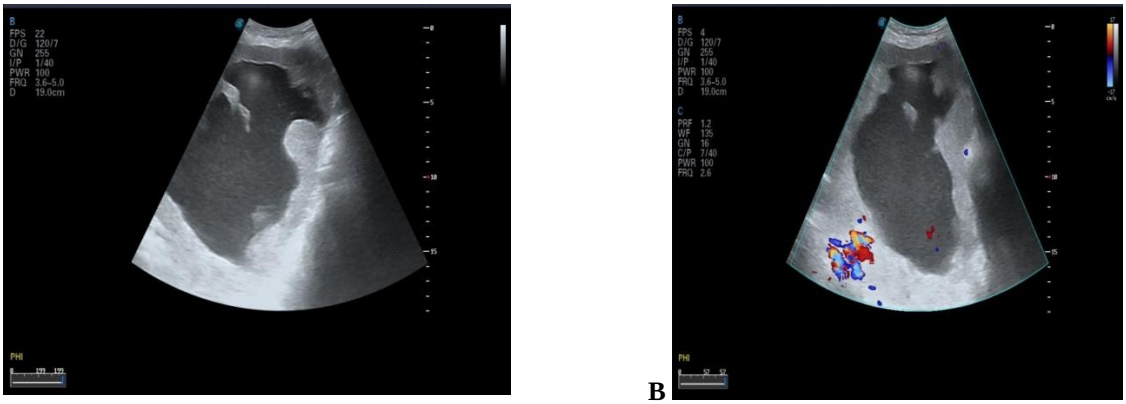
A **B**

(Figure 3): A 35-year-old woman with a pathologically proven endometrioma. **(a)** a Transvaginal ultrasound reveals a unilocular cyst with turbid content (ground glass appearance). **(b)** Color Doppler ultrasound reveals no flow. The lesion was categorized as GI-RADS 3.



A **B**

(Figure 4): A 22-year-old woman(virgin) with a pathologically proven ovarian fibroma. **(a) a** Transabdominal ultrasound reveals a 5cm well-defined solid, smooth contours, heterogeneous echoic appearance mass. **(b)** Color Doppler ultrasound reveals no flow. The lesion was categorized as GI-RADS 4.



A **B**

(Figure 5): A 57-year-old woman (virgin) with a pathologically proven endometrioid adenocarcinoma. **(a)** a Transabdominal ultrasound reveals irregular cystic mass, there is solid component with papillary growth. **(b)** Color Doppler ultrasound reveals flow inside the mass. The lesion was categorized as GI-RADS 5.

Table (5):Diagnostic performance of the Gynecology Imaging Reporting and Data System (GI-RADS).

GI-RADS	Histopathological results		Test of significance	P value
	Benign n=50	Malignant n=55		
2	2(4%)	0(0%)	Fisher-Freeman-Halton Exact Test = 56.061	≤0.001**
3	27(54%)	3(5.45%)		
4	20(40%)	21(38.18%)		
5	1(2%)	31(56.37%)		
Total	105(100%)			
Sensitivity	94.55%			
Specificity	58%			
PPV	71.23%			
NPV	90.63%			
Accuracy	77.14%			

Table (5) shows diagnostic performance of the Gynecology Imaging Reporting and Data System (GI-RADS) were 32 adenexal mass considered benign by the GIRADS classification system (G2 and G3), 29 (58%) masses were found benign by histopathology (true negative) and 3 (5.45%) masses were found malignant by histopathology (false negative). On the other

hand, out of 73 cases considered malignant (G4 and G5), 52 (94.55%) masses were found malignant by histopathology (true positive) and 21 (42%) were proved benign by histopathology (false positive). The GIRADS classification system showed a sensitivity of 94.55%, a specificity of 58%, PPV of 71.23%, NPV of 90.63%, and an overall accuracy of 77.14%.

Table (6): Diagnostic performance of the risk of malignancy index (RMI).

Risk of malignancy index (RMI)	Histopathological results n=105		Test of significance	P value
	Benign n=50	Malignant n=55		
Less than 200 n=56 (53.33%)	45(90%)	11(20%)	Pearson Chi-Square test = 51.563	≤0.001**
More than 200 n=49 (46.67%)	5(10%)	44(80%)		
Total	105(100%)			
Sensitivity	80%			
Specificity	90%			
PPV	89.8%			
NPV	80.36%			
Accuracy	84.76%			

Table (6) shows diagnostic performance of the risk of malignancy index (RMI) where, 56(53.33%) adenexal mass were considered benign by applying RMI (less than 200), 45(90%) were benign(true negative) and 11(20%) were malignant (false negative) by histopathology. Fourty nine adenexal mass were considered malignant by applying RMI (more than 200), of these, 44(80%) were proved malignant (true positive) and 5(10%) were benign (false positive) by histopathology. The RMI showed a sensitivity of 80%, a specificity of 90%, PPV of 89.8%, NPV of 80.36%, and an overall accuracy of 84.76%.

Table (7):Diagnostic performance of MRI

MRI	Histopathological results	
	Benign n=50	Malignant n=55
Benign n=49(46.67)	47(94%)	2(3.64%)
Malignant n=56(53.33%)	3(6%)	53(93.36%)
Sensitivity	96.36%
Specificity	94%
PPV	94.64%
NPV	95.92%
Accuracy	95.24%

Table (7) shows diagnostic performance of MRI where, 49 (46.67%) masses were considered benign by MRI, of these, 47 (94%) were proved benign (true negative) and 2(4.08%) were proved malignant by histopathology (false negative), 56 (53.33%) masses were considered malignant by MRI, of these, 53(93.36%) were malignant (true positive) and 3 (6%) were benign by histopathology (false positive). MRI results showed sensitivity, specificity, PPV, NPV, and an overall accuracy of 96.36%, 94%, 94.64%, 95.92% and 95.24% respectively .

Table (8): Combined diagnostic accuracy of the GIRADS classification and RMI.

GI-RADS and Risk of malignancy index (RMI) together	Histopathological results	
	Benign	Malignant
Benign n=30	28(56%)	2(3.64%)
Malignant n=47	4(8%)	43(78.18)
Sensitivity	95.56%	
Specificity	87.5%	
PPV	89.37%	
NPV	94.71%	
Accuracy	91.72%	

Table (8) shows combined diagnostic accuracy of the GIRADS classification and RMI where, In an attempt to improve the discrimination between benign and malignant adenexal masses, both the GIRADS classification and RMI results were combined for each patient. Combined results showed sensitivity, specificity, PPV, NPV, and an overall accuracy of 95.56%,

87.5%, 89.37%, 94.71% and 91.72% respectively .

Discussion:

There was a direct relation between the age of the patients and the presence of malignant masses, the patients with malignant masses were significantly older than those with benign masses (52.62±14.05 versus 40.86±17.51 years), there's high statistical significance between age in the studied patients and malignant masses which were diagnosed by histopathology, P≤0.001.

The results are consistent with those of **Sharma et al[16]**, the peak incidence of the ovarian tumors was in the fifth decade (24.62%) which was very much similar to the observations of **Valson et al[17]** which revealed 30.85% cases in the 5th decade.

In accordance with our results, **Jha and Karki[18]** examined 164 cases with ovarian masses to study the age distribution of various types of ovarian masses. The authors concluded that most ovarian tumors (47.2%) were seen between 21-40 years while most malignant tumors (73.1%) were seen above 40 years.

Other epidemiological study also showed that the incidence of ovarian cancer increases with age, with a median age at diagnosis of 63 years. Over 80% of ovarian cancers occur after age 45 years[19].

Another epidemiological study stated that when all other risk factors are considered, incidence is highest in women between the ages of 60 and 64[20].

Moreover, these results go hand in hand with the report published by **the Cancer Research UK [21]**, which stated that Age-specific incidence rates rise steadily from around age 15-19 and more steeply from around age 40-44, with a sharp drop in the oldest age groups. The highest rates are in in the 75 to 79 age group in the UK in 2016-2018.

The results of current study have also shown that Diabetes mellitus was among the factors coinciding with development of ovarian malignancy, 7 (14%) of diabetic patients had benign lesions and 19 (34.5%) had malignant lesions. There's statistical significance between Diabetes and malignant masses which were diagnosed by histopathology, P<0.05.

This was supported by results of a meta-analysis which reported a significant association between preexisting diabetes and ovarian cancer incidence. The results of this meta-analysis also suggests that women with diabetes have a moderately increased risk of ovarian cancer by approximately 17%[22].

Our findings are close to the findings of another study carried out by **Wang et al[23]** who found weaker but still association between DM and ovarian cancer risk.

In the present study, hypertension was significantly associated with malignant masses, where 6 (12%) of hypertensive patients had benign masses and 17 (30.9%) had malignant masses. There's statistical significance between hypertension and histopathological results in the studied patients P<0.05.

The results are consistent with those of **Alrobaiq et al[24]** who stated that hypertension, elevated BMI, higher triglycerides, and lower HDL were significantly associated with ovarian cancer.

In the present study, parity was not different between benign and malignant adnexal masses, Where 49 (89.1%) of multipara had malignant lesions and 6 (10.9%) of nullipara had malignant lesions & 38 (76%) of multipara had benign masses

and 12 (24%) of nulipara had benign masses, There's no statistical significance between parity and malignant masses which were diagnosed by histopathology, P=0.064.

Similar to our results, a previous study done by **Hartman et al[25]** included 103 women and showed that parity was not significantly different between the benign and the malignant groups.

However, it is known that nulliparous women have a higher risk for ovarian cancer than multiparous women due to the role of ovulation in ovarian carcinogenesis and theories that suggest that the hormonal changes associated with pregnancy provide a respite from continuous ovarian exposure to estrogen, a known mitogen[20,26].

Our results did not coincide with this of **Chiaffarino et al[27]**, where the mean parity of patients with benign lesions was 2.8, and that for those with malignant masses was 0.9.

This difference could be explained by the smaller sample size in our study & there is less awareness and less usage of contraception in the society of the study.

In the present study, malignant adnexal masses common in postmenopausal patients, where 38 (76%) of pre-menopausal cases had benign masses and 33 (60%) of post-menopausal cases had malignant masses. There's high statistical significance between malignant masses which were diagnosed by histopathology, P≤0.001.

The results are consistent with those of **Basha et al[28]** who stated that Malignant AM were more common in postmenopausal women (71.8%).

In accordance with our results **Hamed [29]** found that Pre- menopausal patients were 82 cases; 71 cases (86.5%) revealed benign pathology, and 11 cases (13.5%) showed malignant lesions. Post- menopausal women were 18 cases; 16 cases (89%) showed malignant lesions and only two cases (11%) had benign lesions.

Similar to our results, **Amor et al[30]** stated in their study that malignant tumors were more frequent in postmenopausal women (43.2%) than in premenopausal women (13.2%), p value < 0.001.

The results of this study have shown that BMI among the factors coinciding with the development of ovarian cancer. BMI was significantly higher in patients with malignant lesions (34.04±5.8 kg/m2) than in patients with benign lesions (29.8±6.7kg/m2) with P=0.006.

In the present study, The incidence of bilateral lesions was high in malignant lesions, Where 41 (55.4%) of unilateral lesions were benign and 22 (71%) of bilateral lesions were malignant, There's high statistical significance between bilaterality of the lesion and malignant masses which were diagnosed by histopathology, P=0.018.

Our findings are close to the findings of another study carried out by **Jha and Karki[18]** which showed that bilaterality was more frequently seen in malignant tumors.

In the present study, 45 patients out of the initial 148 patients were classified as GI-RADS 2. Out of these, 43 showed regression on follow up, and only 2 (1.9%) patients underwent surgery (ovarian cystectomy) due to pain. Only those 2 patients were included in the 105 patients subjected to final analysis and all 2 proved to be benign by histopathology.

Thirty (28.57%) patients were classified as GI-RADS 3. Of these 30 patients, 27 proved to be benign and 3 proved to be malignant by histopathology.

Fourty one (39.05%) patients were classified as GI-RADS 4. Of these 41

patients, 21 proved to be malignant and 20 proved to be benign by histopathology.

Thirty two (30.48%) patients were classified as GI-RADS 5. Of these 32 patients, 31 proved to be malignant and only 1 proved to be benign by histopathology.

The number of malignant cases including borderline cases in the present study was 55 (52.38%). A previous study by **Amor et al[30]** reported different prevalence of 26%.

In our study, the most common benign mass was dermoid cyst 13 (12.38%) and Serous Cystadenoma 12 (11.42%) while the most common malignant mass was serous cystadenocarcinoma 36 (34.28%).

Basha et al[28] examined 609 patient and reported that, the most frequent benign AM was hemorrhagic cyst (20.5%), while the most frequent malignant AM was serous cystadenocarcinoma (29.8%).

Abduljabbar et al[31] examined a total of 244 ovarian masses and reported that functional cysts represent (33.2%), followed by benign cystadenoma which was the most common pathological cyst (19.3%).

Amor et al[32] examined a total of 183 masses and found prevalence of endometrioma (20.2%) which were the most common lesions. There was lower prevalence of cystadenoma (14.7%).

This difference could be explained by the ethnic differences among cases with ovarian tumors.

Regarding the diagnostic performance of the GIRADS , RMI & MRI:

Out of 32 adnexal mass considered benign by the GIRADS classification system (G2 and G3), 29 (58%) masses were found benign by histopathology (true negative) and 3 (5.45%) masses were found malignant by histopathology (false negative). On the other hand, out of 73 cases considered malignant (G4 and G5), 52 (94.55%) masses were found malignant by histopathology (true positive) and 21 (42%) were proved benign by histopathology (false positive).

Fifty six (53.33%) adnexal mass were considered benign by applying RMI (less than 200), of these, 45(90%) were benign (true negative) and 11(20%) were malignant (false negative) by histopathology.

Fourty nine adnexal mass were considered malignant by applying RMI (more than 200), of these, 44(80%) were proved malignant (true positive) and 5(10%) were benign (false positive) by histopathology.

MRI was done to all patients. Fourty nine (46.67%) masses were considered benign by MRI, of these, 47 (94%) were proved benign (true negative) and 2(4.08%) were proved malignant by histopathology (false negative), 56 (53.33%) masses were considered malignant by MRI, of these, 53(93.36%) were malignant (true positive) and 3 (6%) were benign by histopathology (false positive).

Concerning the GIRADS classification system, the results of this study revealed a sensitivity of 94.55%, specificity of 58%, PPV of 71.23%, NPV of 90.63%, and an overall accuracy of 77.14% in differentiating between malignant and benign adnexal masses.

In their study **Migda et al[33]** reported nearly similar sensitivity for this system of 94.3% but specificity of 72.2 %. PPV and NPV were 52.6% and 97.5%, respectively.

The sensitivity and specificity of GI-RADS in the meta-analysis done by **Amor et al[34]** was 98% (96–99) and 88% (77–85). The positive predictive value was 70% (65–75).

The sensitivity and specificity of GI-RADS in the original study of **Amor et al[32]**

were 92% and 97%, respectively. PPV was 85% and NPV, 99%.

The sensitivity for the GI-RADS reporting system in predicting malignancy was 99.1% (95% CI, 95.1–99.8%), specificity was 85.9% (95% CI, 81.7–89.3%).The PPV and NPV were 71.1% and 99.6%, respectively[30].

A study done by **Koneczny et al**[35] compared the IOTA simple rules and the GI-RADS classification in the preoperative evaluation of 271 patients with adnexal masses, Of these 271 masses, 78 proved to be malignant including 6 borderline tumors. Sensitivity for GI-RADS was 88.5% with specificity of 85%.

YASEEN et al[36] have assessed the performance of GIRAD-System, to diagnose malignancy of adnexal lesions in 197 patients. According to their results specificity, sensitivity, negative predictive value and positive predictive value and accuracy were 81.64%, 91.6, 80.82, 28.2, 99.1, correspondingly.

Behnamfar et al[37] reported that comparing with the histopathological diagnosis, the GI-RADS system sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio (LR), and negative LR were 91.6%, 80.82%, 28.2%, 99.1%, 4.77, and 0.10, respectively. The accuracy of the scoring system was 81.64%.

The specificity of the GI-RADS system in the current study lower as compared to that reported in other studies. This could be due to the following factors: small sample size, low number of cases with benign adnexal masses & some features of malignancy as papillae, septations present in benign masses as cystadenoma.

In our study, the RMI showed sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and an overall accuracy of 80%, 90%, 89.8%, 80.36% and 84.76% respectively.

Our findings are close to the findings of another study carried out by **Chopra et al**[38] were the RMI at a cut-off value of 200 had a sensitivity of 96.7 %, specificity of 84 %, positive predictive value of 85.5 %, and negative predictive value of 67.7 %.

Nearly similar results reported by **Auekitrungrueng et al**[39] where sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), were 77.2 (70.4–84.1), 86.8, (83.2–90.5), 71.8 (64.7–78.9), 89.8 (85.0–94.5) respectively.

Javdekar et al[40] reported that: RMI had a sensitivity of 70.5 %, a specificity of 87.8 %, positive predictive value of 70.5 %, and negative predictive value of 87.8 %.

In our study, MRI results showed sensitivity, specificity, PPV, NPV, and an overall accuracy of 96.36%, 94%, 94.64%, 95.92% and 95.24% respectively.

Another study done by **Shimada et al**[41] included 265 patients with adnexal masses which were preoperatively evaluated using the IOTA LR2 model and subjective interpretation of MRI findings by experienced radiologists. MRI sensitivity and specificity were (96% & 91%) respectively.

A meta-analysis of 22 studies on the performance of MRI in diagnosing adnexal masses found an overall sensitivity of 91.9 % and a specificity of 88.4%[42] .

Combined diagnostic accuracy of the GIRADS classification and RMI:

When the GIRADS classification and RMI results were combined, results showed sensitivity, specificity, PPV, NPV, and an overall accuracy of 95.56%, 87.5%, 89.3%, 94.71% and 91.72% respectively. Hence, combining the 2 systems increased the sensitivity, specificity, negative predictive

value and overall accuracy compared to performing either test alone. This decreases the number of false negative cases preventing missed cases of malignancy.

Conclusion:

RMI performed well with adequate sensitivity (80%), high specificity (90%) and overall accuracy (84.76%).

GIRADS performed satisfactory with high sensitivity (94.55%), low specificity (58%) and overall accuracy (77.14%). It accurately diagnosed 29 (58%) of benign lesions as GIRADS 2-3, so saved the patient further imaging and surgical intervention. The increased number of benign lesions mis-classified as GIRADS 4 require additional markers to improve the specificity of GIRADS, so we investigate the combined diagnostic accuracy of the GIRADS and RMI and results were, sensitivity, specificity and an overall accuracy of 95.56%, 87.5% and 91.72% respectively. Hence, combining the 2 systems increased the sensitivity, specificity, and overall accuracy compared to performing either test alone. So our recommendation to improve the discrimination between benign and malignant adenexal masses, both the GIRADS classification and RMI results were combined for each patient. This will decrease the number of misclassified cases, the number of cases requiring additional imaging by MRI.

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