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Diagnostic performance of GI-RADS reporting system in evaluation of adnexal masses

Sahar Mahmoud Abd elsalam^{1*}, Soha Talaat Hamed² and Mohamed Abd elghafar Sayed³

Abstract

Background: Transvaginal and pelvic ultrasound are considered the primary imaging modality in evaluating adnexal masses. Gynaecologic Imaging Reporting and Data System (GI-RADS) depends on different ultrasound patterns and criteria adopted by the International Ovarian Tumour Analysis (IOTA) group. The current study aimed to detect the diagnostic accuracy of the GI-RADS classification in evaluating adnexal masses. In this prospective cross-sectional study, a total of 112 adnexal masses belonging to 100 women, age ranged 12 to 66 years old, were included. The study population was recruited throughout the period between January and November 2017. Ultrasound examination was performed to all patients; different US and Doppler criteria were assessed.

Results: Out of the 112 lesions, 36 (32.1%) were GI-RADS 2, 32 (28.6%) GI-RADS 3, 13 (11.6%) GI-RADS 4, and 31 (27.7%) GI-RADS 5. The GI-RADS classification showed sensitivity 97%, specificity 84.8%, positive predictive value (PPV) 72.7%, negative predictive value (NPV) 98.5%, and accuracy 88.4%.

Conclusion: The GI-RADS reporting system carried a high sensitivity in identifying adnexal masses at high risk of malignancy. The increased number of benign lesions misclassified as GI-RADS 4 required additional markers to improve the specificity in GI-RADS classification.

Keywords: GI-RADS, Adnexal masses, Sensitivity, Benign, Malignant ovarian masses

Background

Adnexal masses are considered common gynaecologic clinical problems. Most lesions are benign necessitating conservative management and follow-up [1, 2]. Ovarian cancer is considered the most lethal gynaecological cancer in women. Annually, it is responsible for an estimated 152,000 deaths, and 239,000 new cases are recorded worldwide [3]. In Egypt, it accounts for 4.1% of all cancers affecting women, considering it one of the most common diagnosed cancers among the Egyptian females [4]. Typically, ovarian cancer presents at late stage when its 5-year survival rate is less than 30% [5].

Adnexal masses are identified primarily by ultrasound [6]. However, since the ultrasound is operator-dependent and the diagnosis of adnexal masses has been usually left to the examiners' impression, many scoring systems, regression models, and neural networks have been suggested for better diagnosis [7–11].

In 2009, Amor and colleagues proposed the Gynaecology Imaging Reporting and Data System (GI-RADS, Table 1) [12], to enhance the communication between radiologists and clinicians. This classification is based on summarized standardized report of ultrasound findings which could provide an estimated risk of malignancy for the examined adnexal mass [13].

Accurate pre-operative assessment of women with adnexal masses is crucial for ovarian reserve in case of non-malignant pathologies particularly in young fertile women [14]. Also, the precise determination of the characteristics

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Table 1 GI-RADS classification system for adnexal masses [11]

GI-RADS grade	Diagnosis	Est. prob. malignancy	Details
1	Definitive benign	0%	Normal ovaries identified, and no adnexal mass seen
2	Very probably benign	< 1%	Adnexal lesions thought to be of functional origin, e.g. follicles, corpora lutea, hemorrhagic cysts
3	Probably benign	1–4%	Neoplastic adnexal lesions thought to be benign, such as endometrioma, teratoma, simple cyst, hydrosalpinx, paraovarian cyst, peritoneal pseudocyst, pedunculated myoma, or findings suggestive of pelvic inflammatory disease
4	Probably malignant	5–20%	Any adnexal lesion not included in GI-RADS 1–3 and with one or two findings suggestive of malignancy*
5	Very probably malignant	> 20%	Adnexal masses with three or more findings suggestive of malignancy*

The asterisk denotes findings suggestive of malignancy included thick papillary projections, thick septa, solid areas with/without ascites and vascularization within solid areas

of the adnexal masses is important in cases when laparoscopy replaces laparotomy because aseptic oncologic methods have to be followed to prevent rupture of adnexal malignant masses [15]. Further, pre-operative suspicion of ovarian cancer enables the examiners to do another imaging modality for proper characterization and staging of the lesions as well as improvement of survival rates [16].

In this regard, the aim of our study was to determine the diagnostic performance of GI-RADS reporting system in the evaluation of adnexal masses and decreased inconclusive ultrasound results.

Methods

Patients

Our observational cross-sectional study included 100 female patients who were attending the outpatient clinics of Obstetrics and Gynaecology and referred to radiology department of University hospital. The study was conducted between January and November 2017.

The study was conducted in full accordance with the guidelines for Good Clinical Practice and the Declaration of Helsinki, and data for patients were collected only after obtaining their informed written consents.

The participating women were asked to fill-in a questionnaire including questions about their age, complaints, and obstetric history. All women were assessed clinically by general and local pelvic examination.

Methods and techniques

Abdominal and transvaginal ultrasound examinations were done for all cases (excluding one patient, aged 12 years virgin, who was evaluated by abdominal ultrasound only). The ultrasound examination was done by one of the two experienced radiologists (10 and 20 years of experience). We used Toshiba Xario 200 and voluson E6 devices to perform the ultrasound examination. Transabdominal scan using a 3.5–5-MHz sector transducer was done.

The examination required filling of the urinary bladder (ideal 1–2 cm above the uterine fundus). Images were obtained in sagittal and transverse planes (oblique image may be needed). To view the adnexa, we moved the transducer from side to side. Transvaginal sonography (TVS) using a 4–8-MHz endoluminal probe after emptying the urinary bladder to minimize discomfort and to bring the uterus and ovaries into the focal zone was performed. The probe was disinfected, ultrasound (US) gel was applied to the transducer head, and a condom was used. Anteroposterior and transverse pelvic planes were done. Colour and power Doppler were done for all cases to detect the vascularity of the lesions and to differentiate between suspicious solid component and benign lesions.

Image interpretation

We assessed the morphological and colour Doppler findings of the lesions. The morphological criteria included the site of the lesion, size, the echopattern, the presence of associated solid component, and the presence of septa or papillary projections. The colour Doppler was used to detect the vascularity, high or low, and vessel arrangement, central or peripheral. Absent or mild peripheral vascularity was considered benign; however, abnormal central vascularity of the solid component was considered suspicious lesions.

We used GI-RADS classification system for adnexal masses, in which GI-RADS 1 was considered definitely benign, GI-RADS 2 very probably benign, GI-RADS 3 probably benign, GI-RADS 4 probably malignant, and GI-RADS 5 very probably malignant (Table 1) [12].

Findings suggestive of malignancy included thick papillary projections, thick septa, solid areas with/without ascites and vascularization within solid areas, papillary projections or central area of a solid tumour on colour or power Doppler assessment as defined according to the International Ovarian Tumour Analysis criteria [11]. According to the GI-RADS classification system,

management protocol is offered to the gynaecologist as shown in Fig. 1.

Histopathologic diagnosis was the gold standard in patients managed by surgical treatment (63 lesions in our study). The other 49 lesions showed resolution and improvement on follow-up ultrasound scans.

Statistical analysis

Data entry, verification, and validation were carried out using standard computer software. Data were analysed using the software, Statistical Package for Social Science (SPSS Inc. Released 2009, PASW Statistics for Windows, version 18.0: SPSS Inc., Chicago, IL, USA) then processed and tabulated.

Frequency distribution with its percentage and descriptive statistics with mean and standard deviation were calculated. Chi-square and *t* test were done whenever needed. *P* values of less than 0.05 were considered significant. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of the GI-RADS system were based on considering GI-RADS 2 and 3 as benign and GI-RADS 4 and 5 as high risk of malignancy.

Results

A total of 100 women with 112 adnexal masses were included in this study. Patients were complaining of pelvic pain, pelvic masses, and/or menstrual irregularities. Patient's mean age was 37.9 ± 12.9 (ranging from 12 to 66 years). Premenopausal patients were 82 cases; 71 cases

(86.5%) revealed benign pathology, and 11 cases (13.5%) showed malignant lesions. Postmenopausal women were 18 cases; 16 cases (89%) showed malignant lesions and only two cases (11%) had benign lesions (Fig. 2, Table 2). Out of the 112 lesions, 36 (32.1%) were GI-RADS 2, 32 (28.6%) GI-RADS 3, 13 (11.6%) GI-RADS 4, and 31 (27.7%) GI-RADS 5 (Fig. 3, Table 3).

The prevalence of malignant lesions by histopathology was 33/112 (29.5%). According to the ultrasound findings, malignant lesions showed thick wall (wall thickness was 4–7 mm, mean 4.16 mm) in 57.6%, compared to only 7.4% in benign lesions ($p < 0.05$). Benign lesions showed no septa in 59% of the lesions and thin septa (less than 3 mm) in 41% of lesions. Also, the diagnosis of malignant lesions associated significantly with thicker septa, papillary projections, and the presence of solid areas: 21.2%, 9.1%, and 33.4% in malignant lesions versus 0%, 0%, and 7.6% in benign lesions, respectively ($p < 0.05$). In addition, all malignant lesions showed Doppler flow. The flow in the malignant lesions was central in 32 lesions (97%) affecting the solid parts, papillae or septa.

Lesions classified as GI-RADS 2 (Fig. 4) included 35 cases presenting with 36 lesions. All lesions were either functional or complicated functional cysts. On follow-up ultrasound, 24 lesions showed complete resolution and 12 lesions revealed stationary course. All cases were premenopausal except one postmenopausal case. The lesions showed thin wall, no papillary projections, and thin septa in 10 lesions.

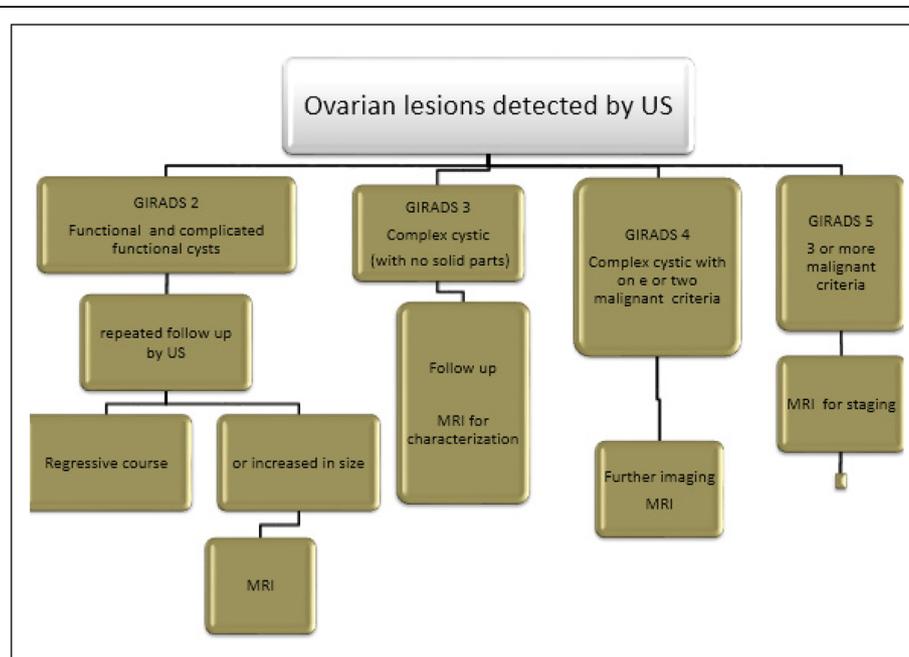


Fig. 1 Suggested algorithm for the diagnosis of ovarian lesions

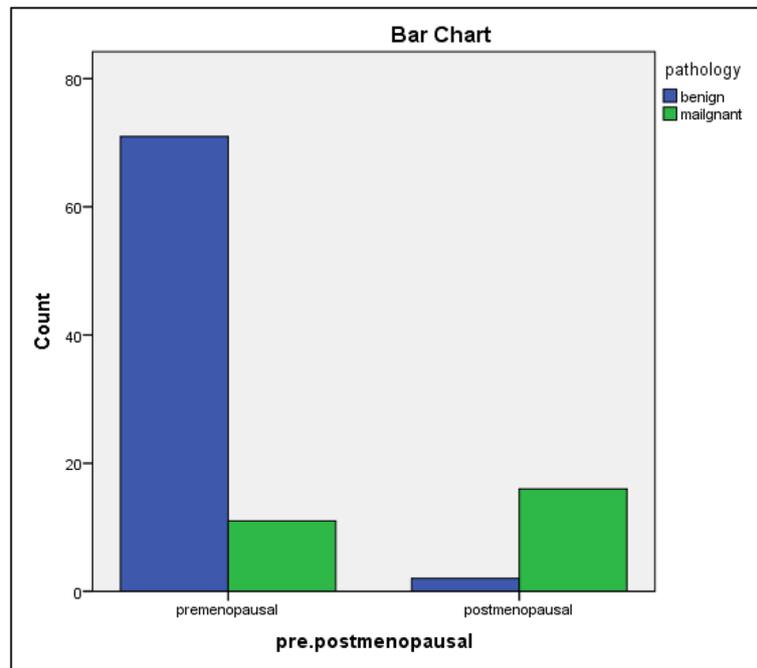


Fig. 2 Correlation between age whether pre- or postmenopausal and the pathology of the lesions

GI-RADS 3 lesions included 17 neoplastic lesions, 6 tubo-ovarian lesions, 7 endometriomas, and 2 paraovarian cysts. The neoplastic lesions included 16 benign lesions and one malignant lesion (false-negative case) diagnosed by histopathology as serous cystadenocarcinoma (48-year-old patient). By transvaginal ultrasound, the lesion was well defined, thin walled, thin septa, no papillary projections, no solid areas (Fig. 5). It showed low-level internal echoes and mild peripheral vascularity. Surgical treatment was done for 19 cases (22 lesions), while 9 cases (10 lesions) showed improvement and spontaneous resolution on follow-up ultrasound examination (Fig. 6).

Lesions categorized as GI-RADS 4 were 13 lesions, 3 of them (23%) proved to be malignant neoplastic lesions (immature ovarian teratoma and primary ovarian carcinoma). The rest of the lesions included five benign neoplastic lesions (serous cystadenomas and one teratoma), two pedunculated subserous fibroid, one endometrioma, and two tubo-ovarian complex. Regarding the benign ovarian neoplastic lesions

misclassified in this group, we found thick walls in two lesions, suspected solid component in two lesions, and associated ascites in one lesion. The tubo-ovarian lesions misclassified in this group; one of them was tubo-ovarian abscess with thick wall and suspected solid component and the other patient had haemorrhagic tubo-ovarian complex which appeared multilocular with increased peripheral vascularity and suspected solid component, the patient gave history of bleeding tendency (Fig. 7). The endometrioma lesion misclassified in this group showed atypical ultrasound appearance. All cases of this group were managed by surgery except two cases including the endometrioma and the haemorrhagic tubo-ovarian complex lesion. They showed improvement on medical treatment. Pelvic MRI was recommended for patients under conservative management, for better lesion characterization.

GI-RADS 5 included 31 lesions, 29 of them were malignant: Primary ovarian malignancies were found in 16 lesions, 3 lesions diagnosed as ovarian lymphoma (Fig. 8), and secondary malignancy in 10 lesions. Two lesions were false positive; one diagnosed as benign fibrothecoma on histopathology (Fig. 9). The other case was ovarian torsion-detorsion with high vascularity (Fig. 10), showing regression on follow-up.

To calculate the overall diagnostic accuracy of GI-RADS classification among the 112 lesions, the ultrasound findings were compared to histopathological references in 55 cases (63 lesions) and the follow-up findings of ultrasound

Table 2 GIRADS classification and patient's age whether pre or postmenopausal

	Premenopausal	postmenopausal	Total
GIRADS 2	34	1	35
GIRADS 3	28	0	28
GIRADS 4	11	0	11
GIRADS 5	9	17	26
Total	82	18	100

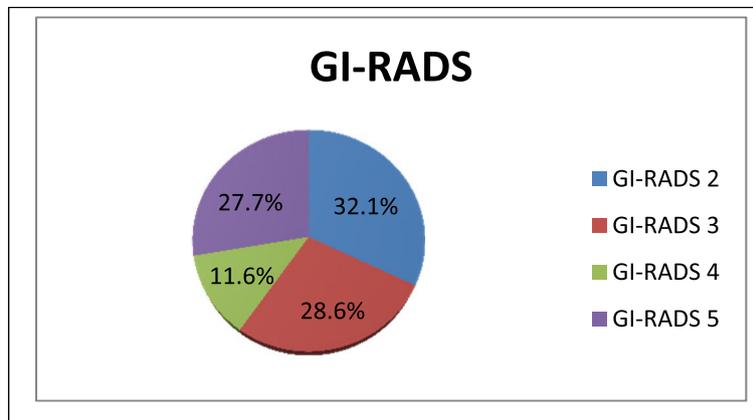


Fig. 3 Distribution of the adnexal lesions by GI-RADS

examination in the other 45 cases (49 lesions). The sensitivity of GI-RADS stood at 97%, specificity 84.8%, positive predictive value 68.1%, negative predictive value 98.5%, and accuracy 88.4% (Table 4).

The total number of ovarian neoplastic lesions in our study was 55 lesions. All neoplastic lesions were managed by surgery. They included 33 malignant and 22 benign lesions. Histopathological classification [17, 18] was done (Table 5). The diagnostic accuracy of GI-RADS classification in diagnosis of ovarian neoplastic lesions is shown in Table 6.

Discussion

Reporting of the precise diagnosis of adnexal masses is an important issue in clinical practice, as inaccurate diagnosis might lead to unnecessary examinations and surgeries, and appropriate diagnosis improves the communication between the medical team and leads to better outcome [19, 20].

This study detected the clinical usefulness of ultrasound reporting system GI-RADS in the diagnosis of

adnexal masses after evaluating different criteria. The prevalence of malignant lesions was 29.5%. Malignant lesions were more likely to show thick walls, thick septa, papillary projections, solid areas, and central blood flow. Postmenopausal patients had higher incidence of malignant lesions while in premenopausal patients, most lesions were benign. In our study, we had one postmenopausal patient classified as GI-RADS 2, the lesion showed regressive course on follow-up ultrasound examination. Postmenopausal women may present with functional or simple ovarian cysts that could be detected by ultrasound examination, saving surgical intervention and unnecessary imaging studies. The presence of functional or simple ovarian cysts in such age group was due to the residual ovarian activity [21].

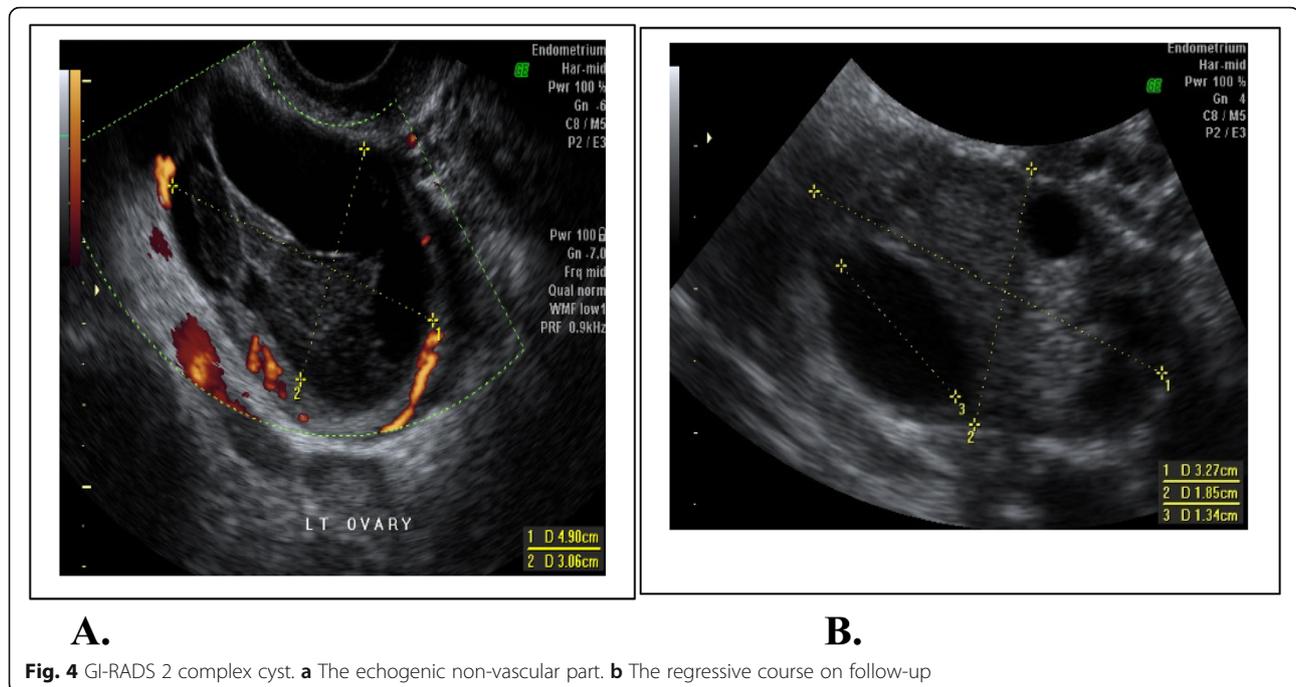
Our results came in consistency with the study done by Zhang and colleagues who conducted a retrospective study over 263 adnexal masses and concluded that thick wall, solid papillary projections, solid areas, and central blood flow were associated with malignant lesions. The sensitivity and specificity of GI-RADS were 96.4% and 84.3%, respectively [22].

The 112 lesions were distributed by GI-RADS classification as the following: 36 (32.1%) GI-RADS 2, 32 (28.6%) GI-RADS 3, 13 (11.6%) GI-RADS 4, and 31 (27.7%) GI-RADS 5. The ovarian neoplastic lesions represented 55 lesions (49%) of the total number of the detected lesions in our study. The diagnostic accuracy of GI-RADS classification in the assessment of ovarian neoplastic lesions according to ultrasound findings and guided by the histopathological classification were 97%, 73%, 84%, 94%, and 87% for sensitivity, specificity, PPV, NPV, and accuracy, respectively.

The present study included one false-negative and twelve false-positive lesions. The false-negative lesion was misclassified as GI-RADS 3, as there was no

Table 3 Distribution of the adnexal lesions by GI-RADS

Adnexal lesions	GI-RADS 2	GI-RADS 3	GI-RADS 4	GI-RADS 5	Total
Functional and complicated cysts	36	0	0	0	36
Ovarian torsion	0	0	0	1	1
Neoplastic lesions	0	17	8	30	55
Paraovarian cysts	0	2	0	0	2
Endometriomas	0	7	1	0	8
Tubo-ovarian lesions	0	6	2	0	8
Pedunculated subserous uterine fibroid	0	0	2	0	2
Total	36	32	13	31	112



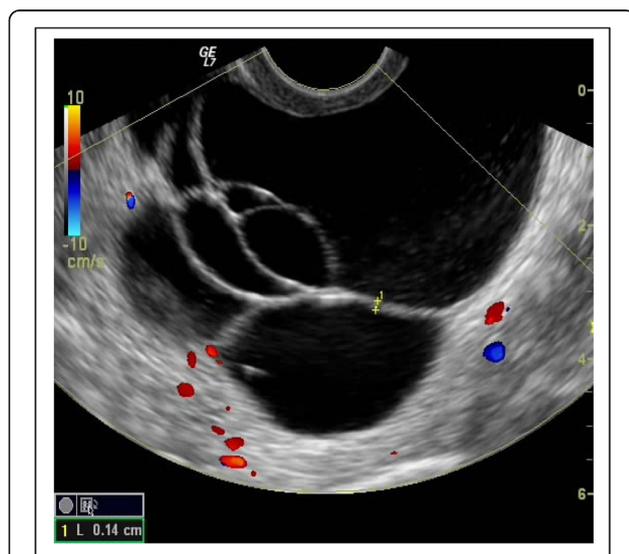
ultrasound findings suggestive of malignancy. The histopathological diagnosis was serous cystadenocarcinoma. This was similar to a study done by Migda et al, who found two malignant lesions out of 119 lesions categorized as GI-RADS 1–3 [23].

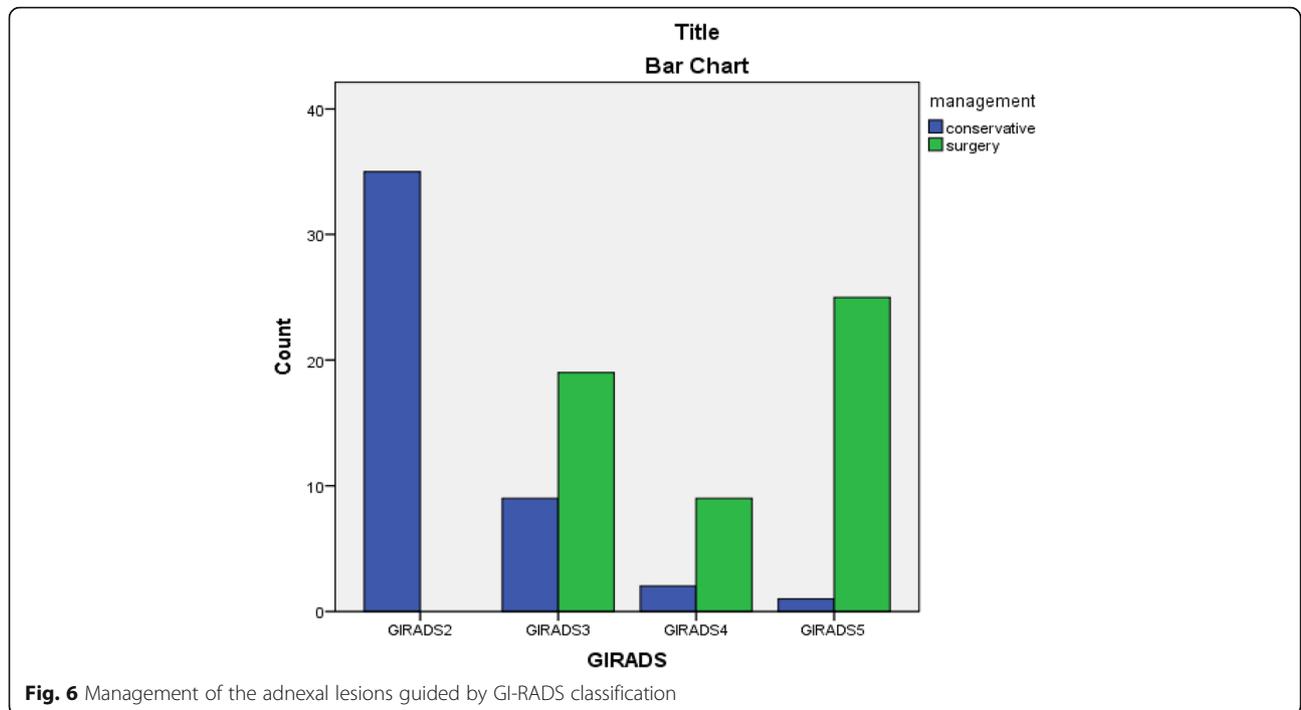
The twelve false-negative lesions included 6 benign ovarian neoplastic lesions, one case with ovarian torsion-detorsion, one endometrioma lesion with atypical ultrasound findings, two tubo-ovarian complex, and two

pedunculated subserous fibroids. In case of ovarian torsion-detorsion misclassified as GI-RADS 5, the patient presented with vague clinical picture and there was no definite history of acute pain. The ultrasound examination revealed a large highly vascular ovary, but on follow-up ultrasound examination, there was regression in the ovarian size and vascularity.

The endometrioma lesion was misclassified as GI-RADS 4 in our study due to the atypical ultrasound findings: multilocular cystic lesion with suspected solid component. Regarding the two tubo-ovarian lesions, there was no recent history of pain or fever; borderline ovarian tumours were considered as a differential diagnosis. This agrees with the previous studies suggesting that about 50% of female patients presenting with chronic tubo-ovarian abscesses may have normal body temperature and nonspecific clinical symptoms including vaginal discharge, abnormal vaginal bleeding, or mild abdominal pain. These clinical signs and symptoms may mimic borderline or malignant ovarian tumours. In such cases, further assessment by pelvic MRI examination for better characterization of the lesions is recommended [24, 25].

In the current study regarding the diagnosis of neoplastic lesions, we had 22 benign lesions and 33 malignant lesions. The GI-RADS classification rates in GI-RADS 4 were 5 benign neoplastic lesions (false positive) and 3 malignant lesions. In GI-RADS 5, there were 29 malignant lesions and one benign neoplastic lesion (false positive). The specificity was 73%. This agrees to a great extent with the study done by Migda et al. [23], who reported 45 benign and 50 malignant lesions. In the GI-RADS 5 group, there





were only malignant lesions while in the GI-RADS 4 group, there were about 45 benign lesions (false-positive lesions) and the specificity of the study was 72%. The false-positive lesion misclassified as GI-RADS 5 in our study due to the solid appearance and the increased vascularity of the lesion was diagnosed as fibrothecoma benign by histopathology.

The present study also agrees with a study done by Amor et al. [12], who reported that no malignant lesion was classified as GI-RADS 2 and one malignant lesion (false negative) was misclassified as GI-RADS 3. Amor et al. [12] found that the prevalence of malignant lesions was 26%. Their lesions were classified by GI-RADS as follows: 92 (21%) GI-RADS 2, 184 (43%) GI-RADS 3, 40

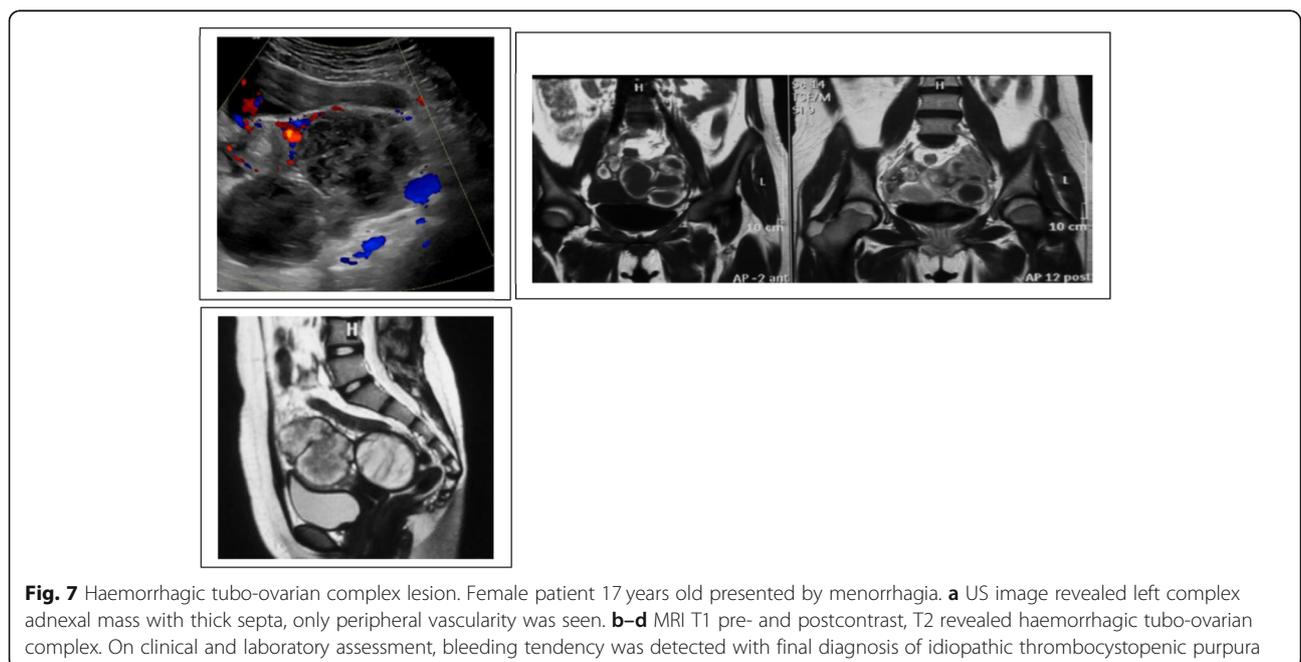
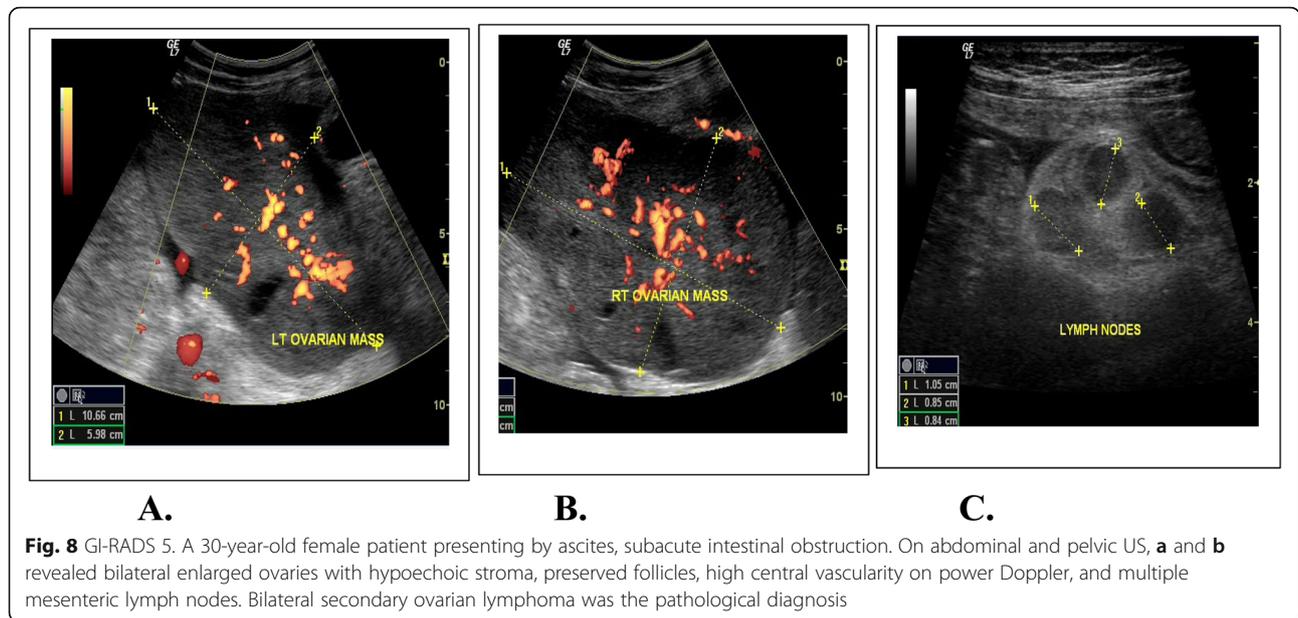


Fig. 7 Haemorrhagic tubo-ovarian complex lesion. Female patient 17 years old presented by menorrhagia. **a** US image revealed left complex adnexal mass with thick septa, only peripheral vascularity was seen. **b–d** MRI T1 pre- and postcontrast, T2 revealed haemorrhagic tubo-ovarian complex. On clinical and laboratory assessment, bleeding tendency was detected with final diagnosis of idiopathic thrombocystopenic purpura

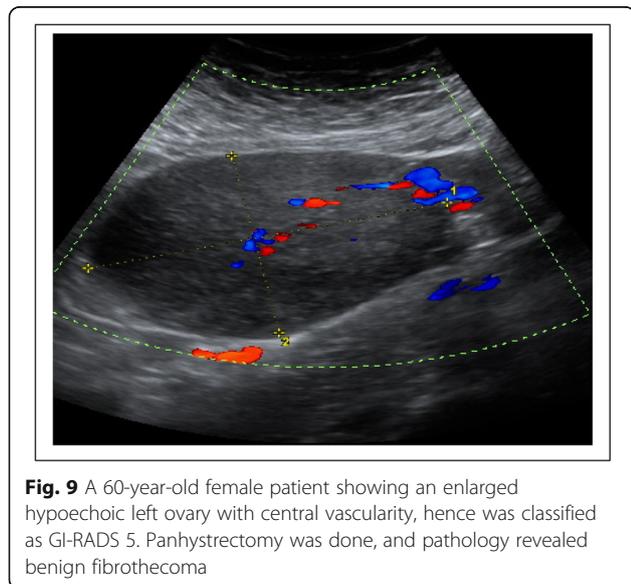


(9%) GI-RADS 4, and 116 (27%) GI-RADS 5, and the sensitivity of the system was 99.1%, specificity 85.9%, PPV 71.1%, and NPV 99.6%.

It is also worth pointing out that GI-RADS reporting system will be of great use as it enhances communication between radiologists and gynaecologists for better diagnosis and proper management of the patients presenting with adnexal lesions based on clinical and ultrasound morphological characteristics of the lesion [12].

Conclusion

We concluded that GI-RADS reporting system performed well with high sensitivity and adequate specificity; it could



accurately diagnose 49 (43.8%) benign lesions as GI-RADS 2–3, so saved the patient’s further imaging and surgical intervention. The increased number of benign lesions misclassified as GI-RADS 4 required additional markers to improve the specificity in GI-RADS classification.

Recommendation

Our recommendations to improve the diagnostic performance of GI-RADS scoring system include patient demographic data, proper history taking, and Doppler

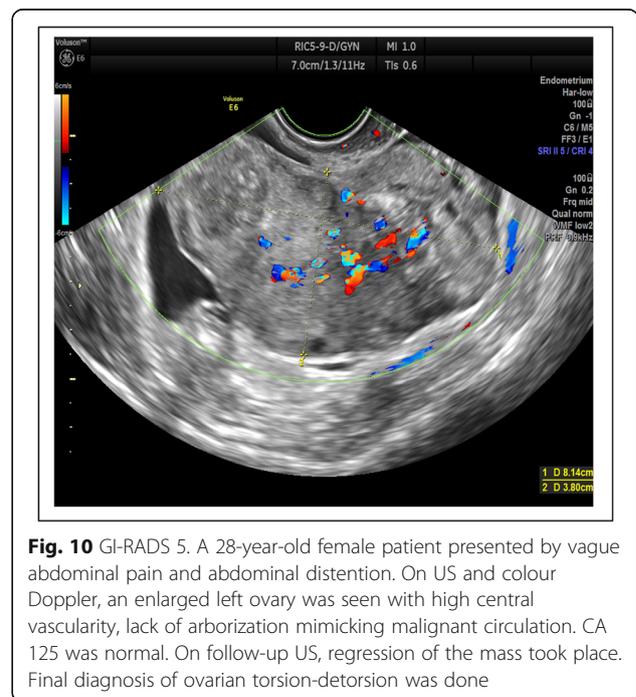


Table 4 The overall diagnostic performance of GI-RADS classification in diagnosis of the detected (112 lesions) ovarian lesions

Ultrasound findings	Final diagnosis	
	Benign <i>n</i> = 79	Malignant <i>n</i> = 33
GI-RADS 2-3	67 (TN)	1 (FN)
GI-RADS 4-5	12 (FP)	32 (TP)
Sensitivity	97%	
Specificity	84.8%	
PPV	72.7%	
NPV	98.5%	
Accuracy	88.4%	

Table 6 The diagnostic accuracy of GI-RADS classification in diagnosis of neoplastic ovarian lesions

Ultrasound findings	Final diagnosis	
	Benign <i>n</i> = 22	Malignant <i>n</i> = 33
GI-RADS 3	16(TN)	1 (FN)
GI-RADS 4-5	6 (FP)	32 (TP)
Sensitivity	97%	
Specificity	73%	
PPV	84%	
NPV	94%	
Accuracy	87%	

Table 5 Correlation between histopathological classification and GI-RADS reporting system [17, 18]

Histopathological classification	GIRADS classification			Total
	GIRADS 3	GIRADS 4	GIRADS 5	
1-Primary ovarian tumours:				
1.1 Surface epithelial stromal ovarian tumours.				
1.1.1 ovarian serous tumours				
Ovarian serous cystadenoma	4	4	0	8
Ovarian serous cystadenocarcinoma	1	0	0	1
1.1.2 Ovarian mucinous tumours				
Ovarian mucinous cystadenoma	1	0	0	1
Ovarian mucinous cystadenocarcinoma	0	0	2	2
1.1.3 Ovarian carcinoma	0	2	11	13
1.1.4 malignant Brenner's tumour	0	0	1	1
1.2 Germ cell ovarian tumours				
1.2.1 Ovarian teratoma				
Mature ovarian (cystic) teratoma	7	1	0	8
Immature ovarian teratoma	0	1	1	2
1.2.2 Primary ovarian choriocarcinoma	0	0	1	1
1.3 Sex cord/ stromal ovarian tumours				
1.3.1 Ovarian fibrothecoma				
Ovarian fibroma	3	0	0	3
Ovarian fibrothecoma	1	0	1	2
2-Others				
2.1 Ovarian lymphoma	0	0	3	5
2.2 Metastatic lesions	0	0	10	10
Total	17	8	30	55

The data coloured in green represents the false positive (6 cases) and false negative case (one case)

study. Further classification of GI-RADS 4 category into subgroups according to the degree of malignancy depending on the examiner's impression and patient age may be required. This will decrease inconclusive ultrasound results, the number of misclassified cases, and the number of cases requiring additional imaging study by pelvic MRI.

Abbreviations

GI-RADS: Gynaecologic Imaging Reporting and Data System; IOTA: International Ovarian Tumour Analysis; NPV: Negative predictive value; PPV: Positive predictive value; TVS: Transvaginal sonography

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Authors' contributions

SA carried out the statistical analysis, data collection, image analysis, drafting, and editing of the paper. SH shared in the image analysis, interpretation, and manuscript editing. MS participated in the data collection and clinical assessment. All contributing authors have read and approved the manuscript.

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Availability of data and materials

All data are available at the corresponding author who has the authority to respond if there is any query.

Ethics approval and consent to participate

The study was approved from the ethical committee of Faculty of Medicine Beni Suef University (FWA00015574). Data were collected after obtaining informed written consent of all cases.

Consent for publication

All patients included in this research gave written informed consent to publish the data contained within this study.

Competing interests

The authors declare that they have no competing interests.

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