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Doppler Ultrasound versus Pelvic Magnetic Resonance Imaging in diagnosis of ovarian mass in teenagers: A Prospective study

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ABSTRACT

Background: Ultrasound (US) is the first radiological modality to examine females with higher suspicion of adnexal lesions owing to its widespread accessibility, affordable cost, and higher sensitivity in mass detection. Magnetic resonance imaging (MRI) offers essential data for the classification of a lot of ovarian masses as neoplastic or non-neoplastic, and benign or malignant. MRI can identify an adnexal mass and plays an essential role as regard to the differentiation between benign and malignant tumours. **Objective:** The current study aimed to compare the diagnostic accuracy of Doppler US and MRI in diagnosis of nature of ovarian mass in teenagers. **Methods:** This was a descriptive prospective study that included 32 patients with 20 years or less and with adnexal mass attending OB/GYN clinic, admitted and prepared for surgery at Mansoura University Hospitals. All patients were examined after explaining of the procedure of transabdominal US or transvaginal US (for married) according to scanning condition and 23 patients had MRI. **Results:** MRI had 100% sensitivity, 90% specificity, 92.8% accuracy and US achieved 87.5% sensitivity, 96.2% specificity and 91.2% accuracy. **Conclusion:** There were no significant differences in sensitivity, specificity, and accuracy of Doppler US and pelvic MRI in characterization of ovarian masses in teenagers. MRI should be used for cases when US results are indeterminate or equivocal, in particular when tumour markers are normal.

Keywords: Neoplasia in the adnexa, Color Doppler ultrasound, International ovarian tumour analysis.

INTRODUCTION

Ovarian masses have been considered as the commonest tumours of the female genital tract in pediatrics and adolescents. Ovarian masses affect about 2.6 cases per 100,000 girls annually in which the malignant ones represent about 1% of whole childhood malignant tumours. About 64% of Childhood ovarian masses are recorded to be neoplastic. About 20% of these tumours are derived from the ovarian surface epithelium, while most of such tumours emerge from germ cells [1]. Ultrasonography is the initial radiological modality to examine females with a higher suspicious of adnexal masses owing to its widespread and low charge, as well as its higher sensitivity in mass identification [2]. A lot of morphologic scores on USG are suggested, according to the wall thickness, septal characteristic, and lesion echogenicity. Color Doppler ultrasound (CDUS) of ovarian masses play an essential role with regard to the differentiation between benign and malignant tumour [3]. In addition, it is utilized in association with pulsed CDUS to recognize the waveform analysis of the vessels. Two indices are utilized in analyzing Doppler waveforms; the PI and the RI. RI below 0.6 and PI below 1.0 are in general considered to be suspicious for malignant tumour [4].

The international ovarian tumour analysis (IOTA) group defined the simple rules according to a set of five US features suggestive of a benign tumour and 5 US features suggestive of a malignant tumour. By utilizing the simple rules, tumours are categorized as benign if only B-features are noticed and as malignant if only M features are noticed. In cases with absence of features or in cases with vague features, the simple rules have no ability to categorize the tumour as cancerous or non-cancerous [5, 6]. In recent years, the IOTA group has designed an approach for more comprehensive characterization of ADNEX. Such approach considers 3 clinical and 6 US features for prediction of the risk of benign ovarian tumour, borderline ovarian tumour, Stage I ovarian cancer (OC), Stage II–IV OC and metastasis [7]. In cases when US results are not conclusive or equivocal, MRI could be considered as a helpful tool with regard to evaluation of adnexal masses. In addition, it play an essential role in proper selection of surgical planning data without radiation exposure [8]. Magnetic resonance imaging could offer precise data in terms of haemorrhage, fat, and collagen. In addition, it has the ability to recognize various forms of tissue comprised in pelvic lesions, differentiating benign from malignant ovarian tumours, with an accuracy ranging from 88% to 93% [9]. This study aimed to compare diagnostic accuracy of Doppler US and MRI in diagnosis of nature of ovarian mass in teenagers.

PATIENTS AND METHODS

This was a descriptive prospective study from May 2021 to November 2022 and included patients attending to Obstetrics and Gynecology Clinic, Mansoura University Hospitals.

Inclusion criteria: Patients with 20 years or less and with adnexal mass attending OB/GYN clinic, admitted and prepared for surgery at Mansoura University Hospitals.

Exclusion criteria: Patient older than 20 years old, with recurrent ovarian mass or with associated pelvic pathology, and patients who received radiotherapy/chemotherapy.

Participants were subjected to detailed history that included personal history (age, marital status, residence & occupation), menstrual history (regular versus irregular cycles), analysis of complains, past surgical procedures or medical diseases. The physical examination included abdominal examination to all

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patients (inspection and palpation), and vaginal examination only to married women.

Investigations: Pre-surgical laboratory investigations were done including CBC, LFT, KFT, RBS & bleeding profile. Tumour markers as AFP, B-HCG, CA125 & LDH were done on suspicion of malignancy.

All patients were examined after explaining of the procedure of transabdominal US or transvaginal US (for married) according to scanning condition. Two Dimensional & Doppler evaluation of adnexal mass were performed. Ultrasonography was done to all patients at Mansoura University Hospitals using Mindray DC-70 Exp and LOGIQ F6 devices. We examined each of the following for each mass: side (right, left, bilateral or mid line), size, nature (cystic, solid or mixed), septations, ascites, solid parts, wall (regular or irregular) and Doppler flow. All the cases were classified according to IOTA ultrasound scoring system and to apply the simple rules, data on the next variables were required: the lesion diameter in millimeter, the diameters of the largest solid component in millimeter, type of tumour (unilocular, unilocular - solid, multilocular, multilocular - solid, solid), existence of wall irregularity, ascites, acoustic shadows, numbers of papillary structures, the colour score and the last reflecting vascularization on Doppler US (I, no flow; II, minimal flow; III, moderate flow; IV, very strong flow).

Predicting Rules [10]:

Rules for predicting benign tumour (B)	Rules for predicting malignant tumour (M)
(B1) unilocular (B2) presence of solid component where the largest solid component has a largest diameter <7mm (B3) presence of acoustic shadows (B4) smooth multilocular tumour with largest diameter <100 mm (B5)no blood flow (color score 1)	Ml) irregular solid tumour M2) presence of ascites M3) at least four papillary structures M4) irregular multilocular solid tumour with largest diameter =100mm M5) very strong blood flow (color score 4)

Rule I: If at least one M feature was present in absence of B feature(s), the mass was categorized as malignant. **Rule II:** If at least one B feature was present in absence of M feature(s), the mass was categorized as benign. **Rule III:** If both M features and B features were existing, or if no B or M features were present, the results were not conclusive and a second stage test was suggested [10].

This second stage was ADNEX model, which is a programmed model. The ADNEX model consisted of 3 clinical predictors and 6 US predictors. **The clinical predictors were** Age (years), Serum CA-125 value (U/mL), type of center where the US was performed. **The US predictors were** the maximal diameter of the lesion (mm), ratio of solid tissue (%) (the ratio of the maximal diameter of the greatest solid component and the maximal diameter of the lesion), number of papillary projections, existence of more than ten cyst locules (yes/no), acoustic shadows (yes/no) and existence of ascites (yes/no).

MRI was done preoperatively at Mansoura University Hospitals using MRI Siemens Aera 1.5 T system and was done only for 23 cases due to lack of resources. MRI classified masses into benign, malignant & inconclusive and data was recorded. After board meeting discussion of each individual case, selected patients for laparotomy or laparoscopy were operated.

The corner stone of diagnosis was postoperative histopathology. The diagnostic role of each radiologic method (Doppler US and MRI) was compared to the solid diagnosis, but unfortunately not all virgins were subjected to frozen sections intra operatively as most of them were admitted through emergency department. All histopathological specimens were examined at Mansoura University Pathology Department.

Ethical Consideration: The current study was approved by IRB of Faculty of Medicine, Mansoura University. Informed written consent was obtained from each participant or their parents. All patients could withdraw themselves from the study without punishment. Privacy was respected. The gathered information wasn't utilized for any different purposes. The study was conducted out in line with the Helsinki Declaration.

Statistical Analysis

Data analysis was conducted by SPSS software, version 25 (Inc., Chicago). Qualitative data were described using number and percent. Quantitative data were defined by utilizing median (Min-Max) for non-normal distribution of data and mean ± SD for normal distribution of data following testing normality by utilizing Kolmogorov-Smirnov test. Significance of the results was judged at the (0.05) level. MC tests was utilized to compare qualitative data between groups as appropriate. Kruskal Wallis and Mann Whitney U test were utilized to compare between two studied groups and more than 2 studied groups, correspondingly for non-normal distribution of the data.

RESULTS

A descriptive prospective study was carried out on 32 cases presented with ovarian mass in teenagers. The mean age of the studied cases was 17.78 (8 -20) years. 87.5% were students, 9.4% housewives and 3.1% employees, 65.6% had rural residence and 75% were single, 59.4% of the patients were admitted to emergency department and 40.6% from outpatient clinics, 3.1% had history of hypothyroidism, 37.5% had positive past surgical history, 78.1% regular menstrual cycles, 15.6% irregular menstruation and 6.2% were

prepubertal. Of the studied cases, 90.6% had abdominal pain, 15.6% had vomiting and 6.2% had abdominal enlargement and iliac pain. Median duration of complaints is 155.16 days ranging from 1 to 730 days.

There was no statistically significant association between histopathological findings and demographic, clinical or duration of compliant (Table 1).

Table (1): Sociodemographic characteristics and history distribution in relation to histopathological findings

	Histopathological findings		**Test of significance**	
	Benign n=29(%)	**Malignant n=4(%)**	**Borderline n=4(%)**	
Age/years Mean ± SD	18.04 ± 3.28	16.33 ± 6.35	17.0 ± 2.65	**F=1.61 P=0.447**
Occupation				
Student	22 (84.6)	3(100)	3(100)	**MC=1.06**
Employee	1 (3.8)	0	0	**P=0.901**
HW	3 (11.5)	0	0	
Residence				
Urban	9(34.6)	1(33.3)	1(33.3)	**MC=0.004**
Rural	17(65.4)	2(66.7)	2(66.7)	**P=0.998**
Marital status				
Single	20(76.9)	3(100)	1(33.3)	**MC=3.83**
Married	6(23.1)	0	2(66.7)	**P=0.147**
Medical Hx				
Free	25(96.2)	3(100)	3(100)	**MC=0.238**
Hypothyroidism	1(3.8)	0	0	**P=0.888**
Past surgical Hx				
-ve	17(65.4)	2(66.7)	1(33.3)	**MC=1.20**
+ve	9(34.6)	1(33.3)	2(66.7)	**P=0.548**
Menstrual cycles				
Regular	20(76.9)	3(100)	2(66.7)	**MC=1.77**
Prepubertal	2(7.7)	0	0	**P=0.778**
Irregular	4(15.4)	0	1(33.3)	
Complaint				
Abdominal pain	23(88.5)	3(100)	3(100)	**MC=0.76, P=0.683**
Abdominal enlargement	1(3.8)	1(33.3)	0	**MC=4.21, P=0.122**
iliac pain	2(7.7)	0	0	**MC=0.49, P=0.782**
vomiting	5(19.2)	0	0	**MC=1.37, P=0.505**
Duration of Complaint/days median (min-max)	30(1-730)	14(10-30)	7(5-547.5)	**KW=0.021 P=0.989**

Table (2) demonstrated Ultrasound findings of the studied cases; 54.1% had right sided lesion, 37.8% were left sided and 8.1% of lesions were midline.

Table (2): Ultrasound findings of the studied lesions (n=37)

US findings		**n=37**	**%**
Side of lesion:	Right	20	**54.1**
	Midline	3	**8.1**
	Left	14	**37.8**
Lesion nature:			
Solid		20	**54.1**
Partially solid partially cystic		3	**8.1**
Cystic		14	**37.8**
Largest diameter/cm median (min-max)		**9.0 (1.0-22.0)**	
Ascites		**8**	21.6
Wall			
Regular		**28**	75.7
Irregular		**9**	24.3

Figure (1) showed that 54.1% of the masses were solid, 8.1% partially solid and partially cystic & 37.8% were cystic. While, **figure (2)** showed that median largest diameter was 9 ranging from 1.0 to 22 cm. Of the studied cases, 21.6% had ascites, and 10.3% had internal septae.

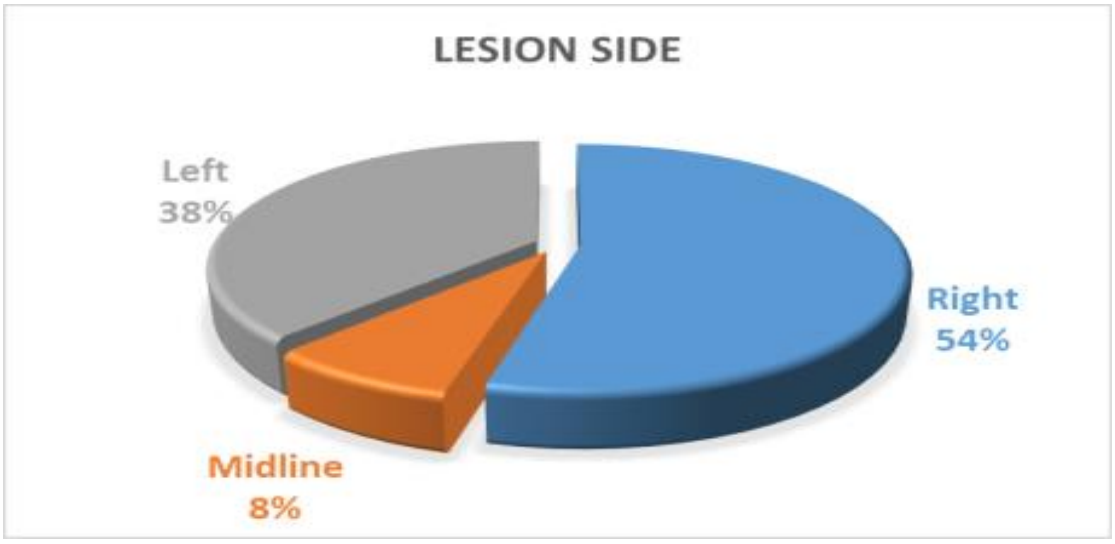

Figure (1): Side of lesion as detected by ultrasound

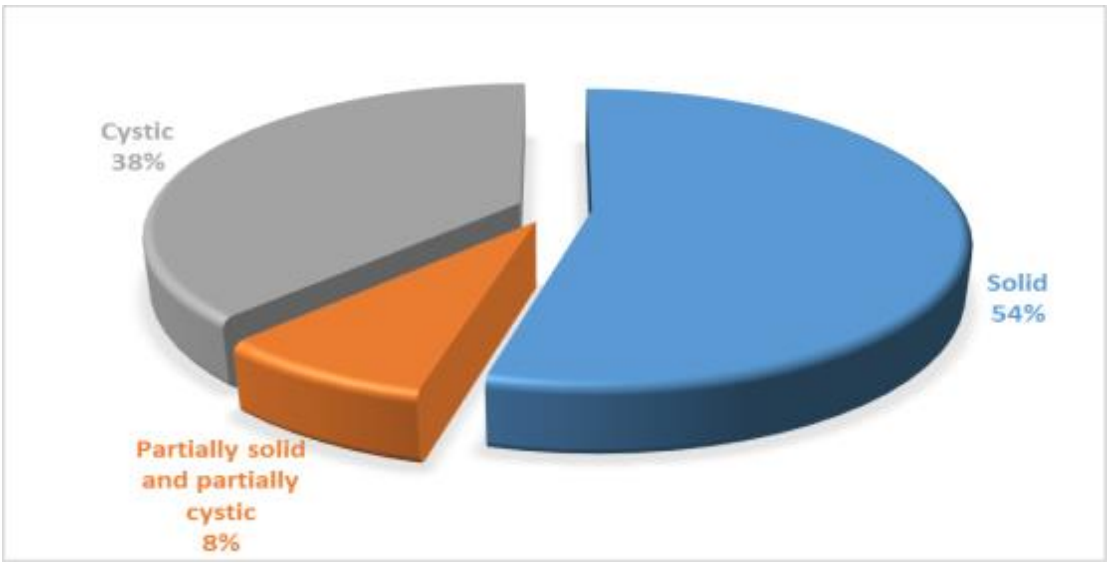

Figure (2): Lesion nature as detected by ultrasound

Table (3) illustrated that 16.2% of cases were unilocular, 32.4% were unilocular with mixed echogenicity, 10.8% unilocular with ground glass appearance, 8.1% were unilocular–solid, 10.8% were solid, 8.1% were multilocular–solid & 13.5% multilocular. Figure (3) illustrated that IOTA simple rules classification of lesions; 75.7% B5, 29.7% B3, 27% B1 and 5.4% B2 & B4. M classification was 18.9% M2, 8.1% M1, M3 & M4 and 5.4% M5. Figure (4) showed that 70.3% benign, 16.2% malignant, 8.1% non (B) & non (M) and 5.4% Both (B) & (M) by ultrasound.

Table (3): Morphology according to IOTA consensus & IOTA simple descriptors

Morphology	**n= 37**	**%**
Unilocular	6	**16.2**
Unilocular With mixed echogenicity	12	**32.4**
Unilocular With ground glass appearance	4	**10.8**
Unilocular - Solid	3	**8.1**
Solid	4	**10.8**
Multilocular - Solid	3	**8.1**
Multilocular	5	**13.5**

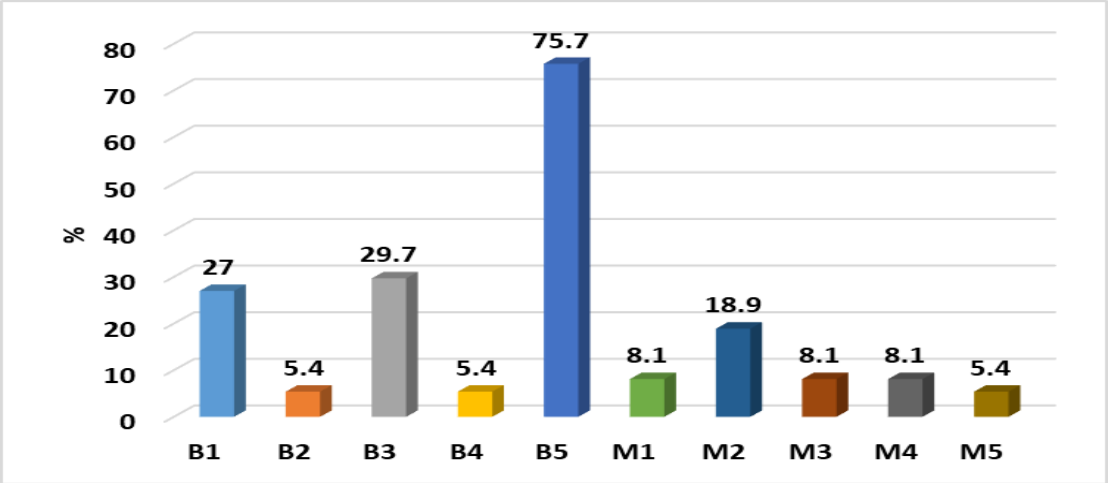

Figure (3): IOTA simple rules classification among studied cases.

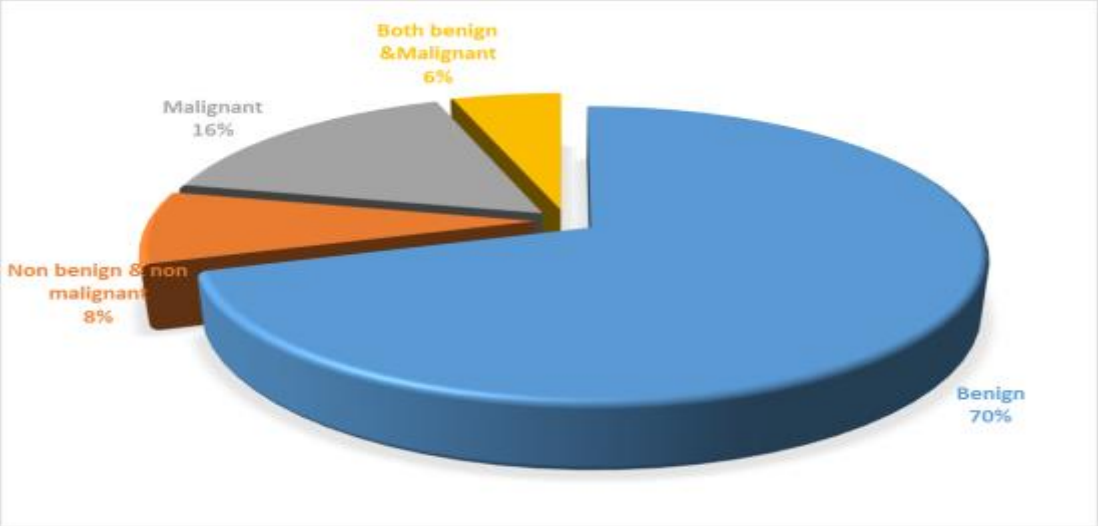

Figure (4): Ultrasound conclusion of the studied cases

Table (4) showed that 28 cases were visualized using MRI, MRI was not done for all lesions, 64.3% of masses were benign, 28.6% were malignant and MRI was inconclusive in 7.1%. While, according to histopathological analysis, 78.4% of masses were benign, 10.8% were malignant and 10.8% were borderline.

Table (4): MRI findings of the studied lesions (n=28)

MRI	n=28#	%
Inconclusive	2	7.1
Benign	18	64.3
Malignant	8	28.6
Histopathology		
Benign	29	78.4
Malignant	4	10.8
Borderline	4	10.8

Table (5) compared MRI and US sensitivity, specificity, PPV, NPV and accuracy. Results showed that MRI had 100% sensitivity, 90% specificity, 92.8% accuracy and ultrasound achieved 87.5% sensitivity, 96.2% specificity and 91.2% accuracy.

Table (5): Validity of MRI & US in diagnosing studied lesions as compared to histopathological findings

	Sensitivity %	**Specificity %**	**PPV %**	**NPV %**	**Accuracy %**
MRI	100.0	90.0	80	100.0	**92.8**
US	87.5	96.2	87.5	96.2	**91.2**

PPV: Positive predictive value, NPV: Negative predictive value

Table (6) showed ultrasound findings and their associations with histopathological findings. There was no significant association between side of lesion and histopathologic examination. There was no significant association between size of the mass and histopathologic examination. A significant association is detected between lesion morphology and histopathologic results. Ascites was detected in 6.9% of benign masses, with increased percentage of ascites in malignant and borderline masses (75% each). 93.1% of benign masses had regular walls; only one malignant mass had a regular wall. Wall irregularity was demonstrated in 6.9% of benign masses, and 75% of malignant masses and in all borderline lesions. There was a statistically significant relation between ultrasound conclusion and histopathological findings. Of the cases with pathologically proven benign lesions; 86.3% were benign, 10.3% non-benign & non-malignant and 3.4% both benign & malignant detected by ultrasound conclusion. Of the cases with malignant lesions; 75% are malignant and 25% benign as detected by ultrasound conclusion. Of the cases with borderline lesions; 75% are malignant and 25% both benign & malignant as detected by ultrasound.

Table (6): Ultrasound findings and US conclusion in relation to histopathological findings

	Histopathological findings			**test of significance**
US findings	**Benign n=29(%)**	**Malignant n=4(%)**	**Borderline n=4(%)**	
Side of lesion:				
Right	16(55.2)	2(50)	2(50)	**MC=2.15 P=0.709**
Midline	2(6.9)	0	1(25)	
Left	11(37.9)	2(50)	1(25)	
Lesion nature:				
Solid	1(3.4)	2(50)	1(25)	**MC=20.76 P<0.001***
Partially solid and partially cystic	3(10.3)	1(25)	3(75)	
Cystic	25(86.2)	1(25)	0	
Morphology (IOTA consensus, IOTA simple descriptors):				
Unilocular	5(17.2)	1(25)	0	**MC=40.62 P=0.001***
Unilocular with mixed echogenicity	12(41.4)	0	0	
Unilocular with GG appearance	4(13.9)	0	1(25)	
Unilocular – Solid	2(6.9)	2(50)	0	
Solid	0	1(25)	3(75)	
Multilocular – Solid	1(3.4)	0	0	
Multilocular	5(17.2)		0	
Largest diameter/cm Median (Min-Max)	9(3-16)	10.25(1-13)	7(4.5-22)	**KW=0.685 P=0.710**
Ascites	2(6.9)	3(75)	3(75)	**MC=17.16 P<0.001***
Wall:				**MC=22.81 P<0.001***
Regular	27(93.1)	1(25)	0	
Irregular	2(6.9)	3(75)	4(100)	
US Conclusion				
Benign	25 (86.3)	1 (25)	0	**MC=30.87 P<0.001***
Non benign & non malignant	3(10.3)	0	0	
Malignant	0	3 (75)	3 (75)	
Both benign & malignant	1 (3.4)	0	1 (25)	

MC: Monte Carlo test, KW: Kruskal Wallis test, *statistically significant, GG: ground glass.

Table (7) showed a significant association between MRI findings and histopathologic examination. Of the benign masses by histopathology, 90% were benign, 10% inconclusive and 0% malignant as detected by MRI. Of the malignant cases, 100% were malignant as detected by MRI. Of the borderline cases, 100% were malignant by MRI.

Table (7): MRI conclusion in relation to histopathological findings

	Histopathological findings			Test of significance
MRI	**Benign n=20 (%)**	**Malignant n=4 (%)**	**Borderline n=4 (%)**	
Inconclusive	2(10.0)	0	0	**MC=28**
Benign	18(90)	0	0	**P<0.001***
Malignant	0(0)	4(100)	4(100)	

MC: Monte Carlo test, *statistically significant.

CASE PRESENTATION

Case (1): A 20-years-old married woman presented with lower abdominal pain for 1 week. Pathological specimen revealed borderline papillary serous tumour. Correlation with IOTA: positive for M2 & M3 [malignant] (Figures 5 & 6).

Figure (5): US showed a unilocular cyst measuring 5.5x5x5.5 cm, with clear fluid inside and bright nodular mural thickening, no vascularity detected by color Doppler… complex ovarian cyst.

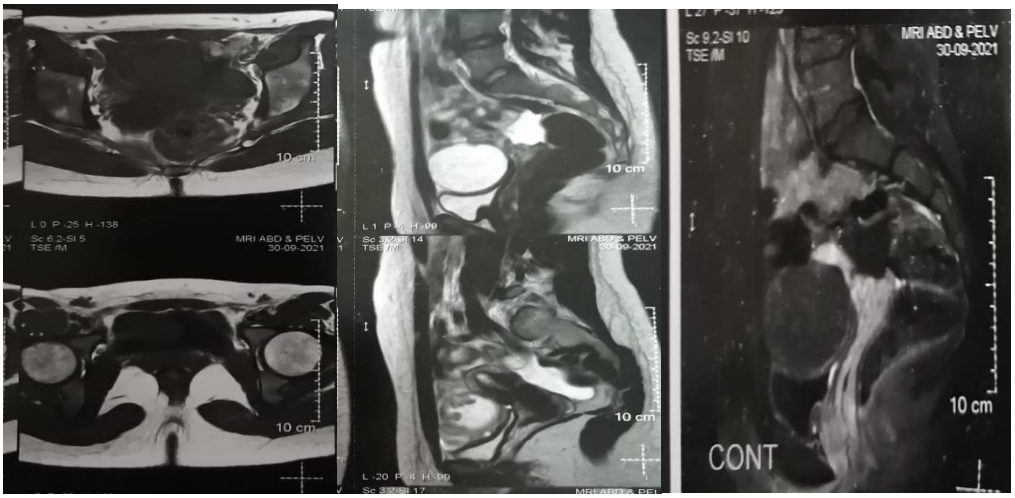

Figure (6): MRI pelvis: Right ovarian cystic mass with a fluid component hyperintense on T2 and hypointense on T1 and a solid component which is hypointense on T2 and isointense on T1.

Case (2): A 20 y old girl presented with lower abdominal pain and enlargement for two months. Pathology revealed: old standing hemorrhagic lesion. Correlation with IOTA: positive for B5 (benign) (Figures 7 & 8).

Figure (7): TAS showed a unilocular cyst measured 12.7x11.2 cm with echogenic component. No vascularity on application of color Doppler.

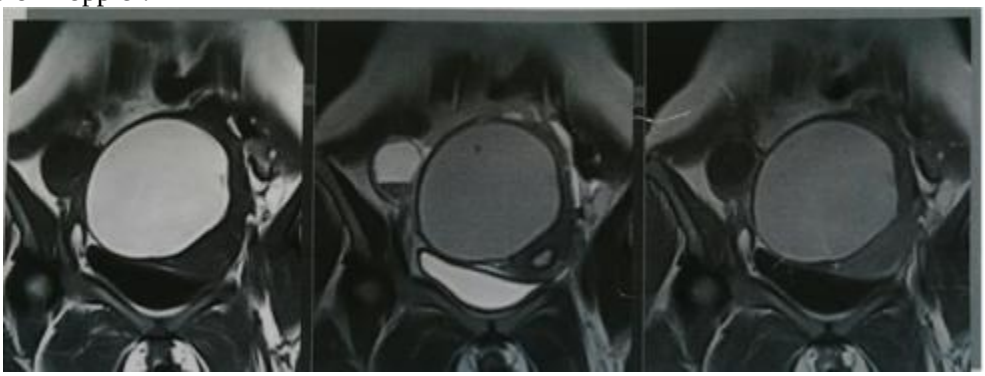

Figure (8): MRI pelvis showed midline pelvic lesion displayed heterogenous signal intensity of high T1and intermediate T2 signal intensity.

DISCUSSION

Adolescent gynecologic pathology is dominated by adnexal tumours [11]. Functional cysts, ovarian torsion and benign masses have been considered the commonest tumours detected in adolescence periods, however approximately 1% of childhood tumours could be malignant ovarian tumours and differential diagnosis with benign tumours is often difficult prior to surgical interference [12]. Of note, US is the initial radiological modality for examination of females with a higher suspicious of adnexal masses owing to its widespread accessibility, low charge, and high sensitivity for detection [13]. The role of Doppler examination is to assess the existence of novel vascularity within the masses [14].

Magnetic resonance imaging (MRI) provides useful data as regards the classification of several ovarian masses as neoplastic or non-neoplastic, and benign or malignant. MRI can identify an adnexal mass and may be useful to differentiate between benign and malignant tumours [15].

The current study aimed to compare the accuracy of Doppler US and MRI in diagnosis of ovarian mass nature among adolescents. The current study was carried out on 32 cases presented with ovarian mass in this age group. The current study illustrated that 59.4% were admitted to emergency department and 40.6% from outpatient clinics, 3.1% had history of hypothyroidism, 37.5% had positive past surgical history. 78.1% of cases had regular menstrual cycles, 15.6% had irregular menstruation and 6.2% were prepubertal. Of the studied cases, 90.6% had abdominal pain, 15.6% had vomiting, 6.2% abdominal enlargement and iliac pain as the presenting complaint. Median duration of complaints is 155.16 days. Our findings are similar to **Arunakumari and Chandra** [16] found that the commonest manifestations of cases with adnexal lesions were lower abdominal pain in 88% cases and lump in the lower abdomen in 32% cases.

The present study demonstrated the US findings of the studied cases; 54.1% had right sided lesion, 37.8% had left sided and 8.1% midline. Nature of the studied cases was distributed as following; 54.1% solid, 8.1% partially solid and partially cystic & 37.8% cystic. Median largest diameter was 9 cm. Of the studied cases; 21.6% had ascites and 10.3% had septae. Additionally, the current study illustrated that 16.2%of cases were unilocular, 32.4% were unilocular with mixed echogenicity, 10.8% were unilocular with ground glass appearance, 8.1% were unilocular–Solid, 10.8% were

solid, 8.1% were multilocular–Solid and 13.5% were multilocular. The current study showed that 70.3% were benign, 16.2% were malignant, 8.1% were non (B) & non (M) and 5.4% were Both (B) & (M) by ultrasound. In the same line, **Zhang *et al.*** [1] have analyzed the clinical features of ovarian lesions in pediatrics as well as in adolescents. US was concurred on 453 (96%) cases to describe the size of the lesion and gross morphological nature, which include a solid mass (n=20, 6%), a complex mass (n=158, 34%), or a cyst (n=275, 60%). In addition, 474 patients (73%) had benign masses and 47 patients (9%) had malignant ones.

The current study illustrated IOTA simple rules classification of the lesion; 75.7% (B5), 29.7% (B3), 27% (B1) and 5.4% (B2 & B4). M classification was 18.9% (M2), 8.1% (M1, M3 & M4) and 5.4% (M5). In harmony with our results, **Garg *et al.*** [17] evaluated the efficacy of IOTA simple US rules in differentiating benign and malignant ovarian tumors. B5 was the commonest occurring factor in whole benign masses, then B1. Rules M1, M2, M4 were all similarly popular factors each present in 8 cases with suspected malignant tumours. Out of this best M factor was M2 (cases with ascetic fluid), which properly predicted malignant tumour in all the eight cases where it was demonstrated.

The current study showed that 28 cases, visualized using MRI findings, were 64.3% benign, 28.6% malignant and 7.1% inconclusive.

Refaat *et al.* [18] evaluated the role of endosonography and traditional MRI for evaluation and differentiation of different adnexal masses in childbearing period females, found that on MRI, 44 (88%) were recorded as benign masses and 6 cases (12%) were recorded as malignant ones. Moreover, the current study reported that MRI findings showed 100% sensitivity, 90% specificity, 92.8% accuracy and ultrasound findings illustrated 87.5% sensitivity, 96.2% specificity and 91.2% accuracy. In accordance with our results, **Refaat *et al.*** [18] have displayed that MRI was associated with a sensitivity and specificity of 100%% and 97.9% respectively in the context of adnexal lesions detection and characterization. Also, **Sohaib *et al*.** [19] demonstrated that accuracy of MRI as regards the detection of adnexal masses was recorded to have a sensitivity of 95% and specificity of 88%. In the same line, the current study is in accordance with **Guerra *et al.*** [20] study that noticed that the MRI sensitivity and specificity for detection of malignant tumours were 98% and 93%, respectively. **Refaat *et al.*** [18] demonstrated that USG has overall sensitivity of 80% and specificity of 95.1%. **Madan *et al.*** [21] showed that the sensitivity of gray scale USG in adnexal masses was 92.5%. Moreover, **Sofic *et al.*** [22] study recorded that overall TVUS sensitivity for entire pathologic adnexal entities was 80.8%.

Interestingly, the current study evaluated many correlations between different imaging modalities and clinical and pathological characters. We have displayed that there was no significant association between ultrasound findings and histopathological findings as regards side of lesion, and presence of septae. A statistically significant association was detected between lesion nature, morphology, ascites, wall (regular or irregular) and histopathological findings. In harmony with our findings, **Timmerman *et al.*** [13] reported statistically significant difference between pathologically confirmed benign and malignant ovarian lesions and solid, Multilocular–solid and multilocular and unilocular morphology. Fluid in POD, septum (mm) and volume of the lesion (mL) ($P<0.01$), denoting associations between these US variables and histopathological diagnosis.

The present study found that there was no significant association between IOTA simple rules and histopathological findings except between B5 and histopathological findings. A significant correlation was detected between M staging and histopathological results. On the other hand, **Garg *et al.*** [17] evaluated 50 patients with suspected ovarian pathology undergoing surgery. IOTA simple rules were applicable in 45 out of these 50 cases (90%). The sensitivity and specificity for malignant tumour detection in cases where IOTA simple rules were applicable was 91.6% and 84.8% respectively. Accuracy was 86.6%, concluding that IOTA simple US rules were associated with high sensitivity and specificity in the context of the prediction of ovarian malignancy preoperatively.

The current study demonstrated statistically significant relation between ultrasound conclusion and histopathological findings. Of the cases with benign lesions, 86.3% were benign, 10.3% were non-benign & non-malignant and 3.4% were both benign & malignant detected by ultrasound conclusion. Of the cases with malignant lesions, 75% were malignant and 25% were benign as detected by ultrasound conclusion. Of the cases with borderline lesions, 75% were malignant and 25% were both benign & malignant as detected by ultrasound conclusion. The current study showed that there was a significant association between MRI findings and histopathological findings. Of the benign cases by histopathology, 90% were benign, 10% were inconclusive and 0% were malignant as detected by MRI findings. Of the malignant cases, 100% were malignant as detected by MRI findings.

Of the borderline cases, 100% were malignant by MRI. Similarly, **Valentini *et al.*** [23] reported that when an adnexal mass is noticed on US evaluation, MRI could be helpfully employed to prove or disprove the benign nature of the lesion as the property of tissue characterizations. MRI is an efficient second confirmatory test and plays an essential role as regards problem solving as MRI criteria for ovarian malignancy are evidently confirmed.

CONCLUSION

Ultrasound is still the main radiological tool in the context of ovarian masses in teenagers with 91.2% accuracy. Moreover, MRI showed 92.8 % accuracy for distinguishing between benign and malignant adnexal masses. There were no significant differences in sensitivity, specificity, and accuracy of Doppler US and pelvic MRI in characterization of ovarian masses in teenagers. So, being expensive and due to our limited resources, MRI should be used for cases when US results are indeterminate or equivocal, in particular when tumor markers are normal.

RECOMMENDATIONS

Ovarian masses in teenagers should gain attention of the families and physicians. Use of abdominal US as the first tool of diagnosis of ovarian masses being cheap, safe, non-invasive & suitable for virgins. MRI was recommended as complementary tool when US results are equivocal.

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