

The accuracy of pelvic magnetic resonance imaging in the diagnosis of ovarian malignancy in Iraqi patients in comparison with histopathology

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Abstract:

Background: Ovarian malignancy is considered to score the highest fatality among women due to lack of significant symptoms. Early diagnosis and treatment lead to good prognosis. Magnetic resonance imaging (MRI) plays a major role in the diagnosis by detecting the lesions and assessing their appearance and consistency.

Objective: To determine the accuracy of MRI in the diagnosis of ovarian malignancy and comparing this to histopathology as a gold standard test.

Patients and methods: A follow up study was conducted in the MRI unit of the Radiology Department in Baghdad Teaching Hospital / Baghdad Medical City Complex during the period from 1st of February to 31st of December, 2017 on a group of thirty women with clinically suspected adnexal mass(es). All patients were examined with MRI including the diffusion-weighted imaging. Surgical specimens were taken for histopathology assessment.

Results: A total of 30 women with adnexal mass were included in this study, with a mean age of 46.8±14.9 years. The MRI T1W image of the cystic part was dark in (60%), while the T2W image of the cystic part was bright (80%), T2W of the solid part was bright in (53.3%), T2W fat saturation of the solid part was bright in the majority (73.3%). T1W fat suppression contrast-enhanced of the solid part was avid in 66.7% of women with an adnexal mass; DWI of the solid part was bright in (76.7%). The mean apparent diffusion coefficient (ADC) value by MRI for women with adnexal mass was 0.9±0.3x10³ mm²/sec. Histopathology mainly revealed mucinous cystadenocarcinoma in (10%) and low-grade serous adenocarcinoma in (10%). Validity of the results of MRI regarding malignant adnexal mass were sensitivity (90.9%), specificity (75%), +ve predictive value (90.9%), -ve predictive value (75%) and accuracy (86.6%). The appropriate cutoff value for apparent diffusion coefficient in differentiation between malignant and benign adnexal mass was 0.97 with 100% sensitivity and 90.9% specificity.

Conclusions: MRI and diffusion-weighted imaging is a valid and reliable technique in the diagnosis and characterization of ovarian malignancy.

Keywords: Ovarian cancer, adnexal lesion, Magnetic Resonance Imaging, diffusion-weighted imaging, Histopathology.

Introduction:

MRI has brought a great jump in the detection and further categorization of adnexal masses into benign and malignant, with additional help achieved by the introduction of diffusion-weighted imaging (DWI) (1). The disease usually presents at a late stage at which time the 5-year relative survival rate is less than 1/3 percent. About (15%) are presented with a

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localized tumor (stage 1) where the 5-year survival rate is more than 90% , (2) In general, the 5-year survival rate ranges between 30%–40% throughout the world and has slightly increased by (2%–4%) since 1995 (3) .MRI can differentiate different types of tissue and fluid by their signal intensity characteristics. Signal intensities of a tumor depend on the presence, type, and extent of solid and cystic parts of the mass, (3) Findings in favor of malignancy include the detection of solid parts, the presence of papillary projections (vegetation), complex solid/cystic masses, and thick septa in a cystic lesion (4) Supportive features of malignancy are mesenteric, peritoneal or omental involvement, lymphadenopathy, and pelvic sidewall invasion. Investigation of the MRI features has shown that the distinctiveness and most in the keeping of

malignancy are papillary projections in a cystic lesion, the presence of ascites, largest diameter greater than 6 cm, and degeneration in a solid lesion(5) The discovery of pelvic ascites, although in favor of malignancy, can be seen in other benign tumor-like ovarian fibroma, both T1- and T2-weighted images are standard sequences for pelvic anatomy and in lesion characterization respectively(6) A small field of view and high-resolution images may be utilized to improve the detection of small structures such as papillary projections(7) Contrast medium enhanced fat-suppressed T1-weighted images intensify the lesion characterization by highlighting of nodules and septa in complex masses, contrast medium-enhanced scans also increase detection of omental and peritoneal implants (8,9). DWI is a newly developed magnetic resonance functional imaging technique, which depends physically on water molecules diffusion rather than gross structural features and anatomical characteristics(10,11) For that, the malignant tumors usually consist of haphazardly organized cells and the thus lacking the free movement of water molecules inside them (12).

Patients & Methods:

This follow up study was conducted in the MRI unit of the Radiology Department in Baghdad Teaching Hospital / Baghdad Medical City Complex during the period from 1st of February to 31st of December, 2017. All women with suspected adnexal masses presenting to the Gynecology Consultancy Clinic and referred to MRI unit of in the same hospital were the study group. The inclusion criteria included age ≥ 18 years with a clinical suspicion of an adnexal mass; while the exclusion criteria were having no histopathology report, patient with a non-ovarian lesion (e.g. pedunculated fibroid, paratubal cyst), known cases of adnexal tumor, recurrent cases of adnexal tumors and women refusing to participate. Thirty women fulfilled the inclusion criteria for the study during the study period. After recording the relevant clinical history and information each case, the researcher examined the woman carefully, and a sonography examination was performed in the same department by the radiologist using ultrasound system (GE health care, Logic S7 Pro, and GE health care, Voluson E6) with a high-frequency linear probe. The patient then underwent the MRI examination following the protocol of the oncology hospital as follows: 1.5-Tsystem (Aera -Siemens) with Gradient Strength; XJ Gradients (33 mT/m @ 125 T/m/s) XQ Gradients (45 mT/m @ 200 T/m/s), by using an eight-channel high-resolution torso coil with array spatial sensitivity technique (ASSET) parallel acquisition. MR sequences: Localizer sequence in the three spatial planes, Axial T2-weighted HASTE sequence, Sagittal T2-weighted HASTE sequence, Oblique coronal T2-weighted FSE sequence, Oblique axial T2-weighted FSE sequence, Oblique axial T2-weighted FSE sequence, Sagittal or axial oblique or

coronal oblique fat-suppressed T2-weighted FSE sequence, Axial DWI SE EPI and Transverse and sagittal T1 fat suppression-weighted gradient-echo images before and after intravenous gadolinium injection. The biopsy material taken by the surgeon was sent to the Histopathology laboratory of Baghdad Teaching hospital. Follow up of the women was done by the researcher through phone calls and interviews for the 3-month duration to acquire the investigations and histopathology results. Ethical considerations: The ethical approval was obtained from Baghdad Teaching hospital authority; the researcher informed the responsible physician about any deterioration of women status, and a verbal and written informed consent was taken from patients.

Statistical analysis:

All the relevant data was entered using computerized statistical software; Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics presented as (mean \pm standard deviation) and frequencies as percentages. Multiple contingency tables conducted and appropriate statistical tests performed, Fishers exact test used for categorical variables. Independent sample t-test was used to compare between two means. ROC curve was used to measure the appropriate cutoff value of ADC. In all statistical analysis, level of significance (p value) set at ≤ 0.05 .

Results:

A total of 30 women with an adnexal mass were included in this study. The mean age was 46.8 ± 14.9 years; they were more or less evenly distributed among the age groups. The age distribution is shown in table 1.

Table 1: Age distribution of women with an adnexal mass.

Variable	No.	%
Age mean \pm SD (46.8 \pm 14.9 years)		
<30 years	6	20.0
30-39 years	5	16.7
40-49 years	6	20.0
50-59 years	7	23.3
≥ 60 years	6	20.0
Total	30	100.0

The MRI T1W image of the cystic part was dark in (60%), and bright in 33%. T2W image of the cystic part was bright in (80%) and dark in (13.3%). T2W of the solid part was bright in (53.3%), and low in (10%). T2W fat saturation of the solid part was bright in the majority (73.3%), and dark in (6.7%). T1W fat suppression contrast-enhanced of a solid part was avid in 66.7% of women with an adnexal mass and minimal in 33.3% of them. DWI of the solid part was bright in (76.7%) and dark in (6.7%). The mean ADC value by MRI for women with

adnexal mass was $0.9 \pm 0.3 \times 10^3$ mm²/sec. All these findings were shown in table 2.

Table 2: MRI findings of women with an adnexal mass

Variable	No.	%	No.	%
T1W image	cystic part		solid part	
Bright	10	33.4		
Dark	18	60.0	4	13.3
Low	1	3.3	23	76.7
Heterogenous	1	3.3	3	10.0
Total	30	100.0	30	100.0
T2W image	cystic part		solid part	
Bright	24	80.0	16	53.3
Low	4	13.3	3	10.0
Heterogenous	2	6.7	11	36.7
Total	30	100.0	30	100.0
T2W fatsat of solid part				
Bright	22	73.3		
Dark	2	6.7		
Low	3	10.0		
Heterogenous	3	10.0		
Total	30	100.0		
T1W fat suppression contrast enhanced of solid part				
Avid	20	66.7		
Minimal	10	33.3		
Total	30	100.0		
DWI of solid part				
Bright	23	76.7		
Dark	2	6.7		
Low	5	16.8		
Total	30	100.0		
ADC value of solid component	(0.9±0.3 x10 ³ mm ² /sec)			

Histopathology mainly revealed mucinous cystadenocarcinoma (10%) and low-grade serous adenocarcinoma (10%). Other histopathological findings were shown in table 3. The validity results of MRI regarding malignant adnexal mass were sensitivity (90.9%), specificity (75%), +ve predictive value (90.9%), -ve predictive value (75%) and accuracy (86.7%). All these findings were shown in table 4.

Table 4: Validity test results of MRI findings in comparison to histopathology.

Validity test	Histopathology		
	Malignant	Benign	Total
	No. (%)	No. (%)	(100.0%)
MRI Malignant	20 (90.9)	2 (9.1)	22
Benign	2 (25.0)	6 (75.0)	8
Total	22 (73.3)	8 (26.7)	30
Sensitivity	90.9%		
Specificity	75%		
+ve predictive value	90.9%		
-ve predictive value	75%		
Accuracy	86.7%		

The appropriate cutoff level and the corresponding validity tests values (sensitivity and specificity) for MRI ADC in differentiation between malignant and

benign adnexal mass are shown in table 5 and figure 1, cutoff ADC of 0.97 had acceptable validity results (100% sensitivity and 90.9% specificity) prediction of malignant adnexal mass.

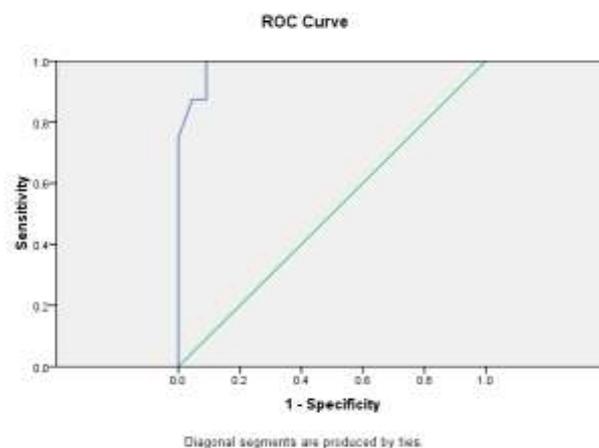


Figure 1: ROC curve for MRI-ADC value prediction of malignant adnexal mass (AUC=0.98).

Discussion:

The standard role of variable imaging modality in adnexal tumors is to reduce the occurrence of an incorrect positive diagnosis and hence avoiding surgery. This will prevent the unnecessary loss of the ovaries and / or the uterus, hence decreasing the chance of infertility. Imaging plays an important role in the early diagnosis of ovarian cancers, thus improving the surgical results and decreasing morbidity and mortality rates (13). The MRI is a leader in increasing the characterization of adnexal masses and thus increasing the specificity particularly for indeterminate lesions by ultrasound and for extremely large masses (14). The present study revealed validity results of MRI in the diagnosis of malignant adnexal tumors as sensitivity (90.9%), specificity (75%), +ve predictive value (90.9%), -ve predictive value (75%) and accuracy (86.6%). These results regarding MRI sensitivity are close to the results of Taj-Aldean study (15) in Iraq which reported MRI sensitivity in the diagnosis of adnexal malignancy as 93.7%. However, there was a difference between two studies in the level of specificity which the latter reported to be 98.4%. This difference might be accredited to the larger sample size of that study compared to our study. The validity results of the current study are close to results of Fan et al (16) study in China which stated that diffusion-weighted (DW) MRI had a sensitivity of 93% and specificity of 88% in differentiating between malignant and benign adnexal masses. Our validity results of MRI are lower than results of Guerra et al (17) study in Portugal which revealed MRI sensitivity of 98%, specificity of 93%, +ve predictive value of 92%, -ve predictive value of 98% and accuracy of 95% in the diagnosis of malignant

adnexal masses. In Brazil, Pereira et al (18) conducted a study on 237 women with adnexal masses using ADNEX MR scoring which showed that MRI sensitivity and specificity in the diagnosis of malignancy were 94.9% and 97.5%, respectively. The MRI is shown to have high sensitivity in diagnosing malignant adnexal mass approaching 96.6% while the specificity is between 83.7% – 94.0% (19, 20). Anthoulakis et al (21) meta-analysis in Greece compared between MRI and other imaging tools like ultrasonography with color, spectral Doppler imaging and positron emission tomography in the examination of ultrasound indeterminate masses and shown a higher accuracy of MRI in the characterization of malignant adnexal masses reaching to a sensitivity of 90-95% and a specificity of 70-80%. The current study showed that the mean ADC value by MRI for women with adnexal mass was significantly lower among women with malignancy by histopathology ($p < 0.001$). This finding is consistent with results of Whittaker et al (22) study in the UK which reported that MRI-ADC values were lower in women with malignant adnexal masses than those with benign masses. Kim et al (23) study in South Korea, on the other hand, revealed no significant difference in ADC value between benign and malignant adnexal masses and reported a lower ADC values in endometrioma and teratoma as compared to malignancy, determining that ADC values were higher in tissues of cystic components than in that with solid parts. Based on that, we advise to limit the use of ADC to cases of suspected malignant lesions, not to those lesions that appear clearly benign. In Egypt, Mansour et al (24) study showed no significant difference in ADC values between malignant and benign masses of fibrous components, but pointing at a significant difference in ADC values between malignant and benign masses of fatty origin. Our study revealed that an appropriate cutoff value of ADC in differentiating between malignant and benign adnexal masses was $0.97 \times 10^3 \text{ mm}^2/\text{sec}$, with a sensitivity of 100% and specificity of 90.9%. This finding is higher than the results of Abd kadhim et al (25) study in Iraq which suggested an appropriate cutoff value of $0.92 \times 10^3 \text{ mm}^2/\text{sec}$ for MRI-ADC with a sensitivity of 54.8% and specificity of 59.1% in differentiation between malignant and benign adnexal masses. Khaled et al (26) study in Egypt reported a cutoff value for MRI-ADC of $0.9 \times 10^3 \text{ mm}^2/\text{sec}$ in differentiating between malignant and benign adnexal masses, with satisfactory validity results of 100% sensitivity and 88.9% specificity. Malek et al (27) study in Iran 47 patients with adnexal masses using 3 Tesla MRI techniques: ADC value, diffusion-weighted Imaging (DWI) and time intensity curve (TIC) of dynamic contrast-enhanced MRI in differentiating between malignant and benign adnexal masses and documented all above MRI techniques are sensitive and reliable for the diagnosis of malignant adnexal masses, but when comparing between them, they found that TIC was

more valid than DW and ADC methods as the ADC is measured quantitatively to estimate the diffusion ability (28, 29). In the present study, women with the low T1W image of solid part and bright T2W image of cystic and solid parts were significantly associated with malignancy. These findings are similar to the results of Cardia study (30) in Brazil. Indeed, women in our study with bright T2W fatsat of a solid part, avid T1W fat suppression contrast-enhanced of solid part and bright DWI of the solid part were significantly associated with malignancy of adnexal mass. These findings are in agreement with results of Vargas et al (31) in USA which indicated that different MRI characteristics are significantly predictive of the malignancy of adnexal masses.

Conclusions:

The diffusion-weighted MRI is a valid and reliable technique in the diagnosis and characterization of adnexal masses. The MRI ADC value below 0.97 has a higher validity in the prediction of malignant adnexal masses.

Authors' Contributions:

Saba Qais: student ather the cases writing the research and do statistical analysis ,Khaleel Ibraheem Mohson: supervisor ,give instruction about the Data collection ,review he MRI sequences and review the framework of the article , Nawras K. Fadhil, give detailed information about the contrast medium and made proof reading for the article

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دقة الفحص باستخدام الرنين المغناطيسي في تشخيص الأورام الخبيثة في المبيض بالمقارنة مع التشخيص النسيجي

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الخلاصة :

نبذة: التشخيص المبكر والعلاج من الأورام الخبيثة للمبيض مصحوبان بتنبؤات حياتية جيدة. التصوير بالرنين المغناطيسي له درجة عالية من الدقة في التصنيف المبكر لأورام المبيض.

الهدف من الدراسة: لتحديد دقة التصوير بالرنين المغناطيسي في تشخيص الأورام الخبيثة في المبيض بالمقارنة مع التشريح المرضي كاختبار ذهبي.

المرضى وطرق البحث: دراسة متابعة مستقبلية أجريت في وحدة التصوير بالرنين المغناطيسي في قسم الأشعة بمستشفى بغداد التعليمي في مجمع مدينة الطب في بغداد خلال الفترة من 1 فبراير 2017 إلى 31 ديسمبر 2017 على عينة من 30 امرأة مشتبهة بالإصابة بورم المبيض. تم فحص جميع المرضى مع التصوير بالرنين المغناطيسي الموزون الانتشار وتم جمع العينات لفحص التشريح المرضي.

النتائج: كانت نتائج صلاحية التصوير بالرنين المغناطيسي فيما يتعلق بأورام المبيض الخبيثة حساسية (90.9%) وخصوصية (75%) وقيمة تنبؤية موجبة (90.9%) وقيمة تنبؤية سالبة (75%) ودقة (86.6%). كانت قيمة القطع المناسبة لمعامل الانتشار الظاهر في التمايز بين الكتل الضامة الخبيثة والحميدة 0.97 مع حساسية 100% وخصوصية 90.9%.

الاستنتاجات: إن التصوير بالرنين المغناطيسي المدعوم بخاصية الانتشار هو تقنية صالحة ويمكن الاعتماد عليها في تشخيص وتوصيف أورام المبيض.

مفتاح الكلمات: سرطان المبيض، العقد المبيضية، الرنين المغناطيسي، خاصية النفاذية للرنين المغناطيسي، الفحص النسيجي