

## EFFICACY OF NON-CONTRAST MRI STUDIES IN CHARACTERIZATION OF ADNEXAL MASSES COMPARED TO CONTRAST STUDIES

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### ABSTRACT:

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**Background:** Adnexal masses are common incidental finding during imaging, which cause diagnostic dilemma. Appropriate preoperative evaluation to discriminate between benign and malignant adnexal masses helps to decide the best management and improves survival rate. The most accurate diagnostic method is the contrast MRI to differentiate benign from malignant adnexal masses. Contrast MRI is contraindicated in patients with chronic kidney diseases as well as it may cause allergic reactions. In addition, contrast studies need more time and are expensive. So, Non-contrast MRI may be a diagnostic alternative method when the administration of intravenous contrast medium is not possible.

**Aim of the Work:** Detection of the sensitivity and specificity of abbreviated non-contrast MRI compared with contrast MRI study in evaluation of adnexal masses by using non-contrast and O-RADS scoring systems with detection of inter-reader agreement.

**Patient and Methods:** This study included 30 patients had adnexal masses with age ranging from 18 to 78 years, referred to MRI unit in Ain Shams University Hospitals from February 2022 to January 2023. Comparison between Non-Contrast MRI and ORADs scoring system was done to interpret sensitivity and specificity of non-contrast MRI study. Comparison between readers was done to interpret inter-reader agreement

**Results:** Non-Contrast MRI study compared with Contrast MRI study showed high specificity (92.3%), high sensitivity (100%) and high accuracy (95%). There was no statistically significant difference found between contrast & non-contrast MRI with high inter-reader agreement.

**Conclusion:** Non-contrast MRI has high accuracy and high inter-reader agreement for characterization of adnexal masses. So, Non-Contrast MRI can be a safe alternative method when contrast use is contraindicated.

**Keywords:** Adnexal masses, Non-Contrast MRI, Contrast MRI, O-RADS MRI score.

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### INTRODUCTION:

Adnexal masses are common in the female genital system. They are differentiated into benign and malignant masses. Early

diagnosis and accurate staging are important for patient management. To avoid unnecessary surgery for benign lesions and to optimize surgical cytoreduction for ovarian cancers.<sup>1</sup>

Transvaginal ultrasound is the most used technique. It is a non-invasive, affordable imaging method for assessment of adnexal masses. But there is 5–20% of adnexal masses remain uncharacterized by ultrasound.<sup>2,3</sup>

Magnetic resonance imaging (MRI) can be used in evaluation, characterization and staging of the adnexal masses. It provides high spatial and contrast resolution in delineation of the anatomical structures as well as characterization of pathological lesions.<sup>4</sup>

Characterization of adnexal masses is assessed by using O–RADS MRI scoring system interpretation of contrast MRI (**figure 1**). But the administration of GBCAs (Gadolinium-based contrast agent) may

cause the development of nephrogenic systemic fibrosis or allergic reactions and it is contraindicated in pregnant women.<sup>5,6</sup>

So, our study aimed to detect if Non-contrast MRI study can be diagnostic alternative when the administration of intravenous contrast medium is contraindicated.

A non-contrast MRI study yields score 0 on O–RADS MRI scoring system (incomplete study). So, it assessed by Non-contrast MRI scoring system (**figure 2**). It is a simple 5-point scoring system which aimed to be a practical qualitative score using morphological assessment and basic comparison of tumor signal intensities on T2, DWI and ADC map with reference to standard tissues.<sup>7</sup>

O-RADS MRI Risk Stratification and Management System

O-RADS MRI Score	Risk Category	Positive Predictive Value for Malignancy <sup>^</sup>	Lexicon Description
0	Incomplete Evaluation	N/A	N/A
1	Normal Ovaries	N/A	No ovarian lesion Follicle defined as simple cyst ≤ 3 cm in a premenopausal woman Hemorrhagic cyst ≤ 3 cm in a premenopausal woman Corpus luteum +/- hemorrhage ≤ 3 cm in a premenopausal woman
2	Almost Certainly Benign	<0.5% <sup>^</sup>	Cyst: Unilocular- any type of fluid content <ul style="list-style-type: none"> <li>No wall enhancement</li> <li>No enhancing solid tissue*</li> </ul> Cyst: Unilocular – simple or endometriotic fluid content <ul style="list-style-type: none"> <li>Smooth enhancing wall</li> <li>No enhancing solid tissue</li> </ul> Lesion with lipid content** <ul style="list-style-type: none"> <li>No enhancing solid tissue</li> </ul> Lesion with "dark T2/dark DWI" solid tissue <ul style="list-style-type: none"> <li>Homogeneously hypointense on T2 and DWI</li> </ul> Dilated fallopian tube - simple fluid content <ul style="list-style-type: none"> <li>Thin, smooth wall/endosalpingeal folds with enhancement</li> <li>No enhancing solid tissue</li> </ul> Para-ovarian cyst – any type of fluid <ul style="list-style-type: none"> <li>Thin, smooth wall +/- enhancement</li> <li>No enhancing solid tissue</li> </ul>
3	Low Risk	~5% <sup>^</sup>	Cyst: Unilocular – proteinaceous, hemorrhagic or mucinous fluid content*** <ul style="list-style-type: none"> <li>Smooth enhancing wall</li> <li>No enhancing solid tissue</li> </ul> Cyst: Multilocular - Any type of fluid, no lipid content <ul style="list-style-type: none"> <li>Smooth septae and wall with enhancement</li> <li>No enhancing solid tissue</li> </ul> Lesion with solid tissue (excluding T2 dark/DWI dark) <ul style="list-style-type: none"> <li>Low risk time intensity curve on DCE MRI</li> </ul> Dilated fallopian tube – <ul style="list-style-type: none"> <li>Non-simple fluid: Thin wall /folds</li> <li>Simple fluid: Thick, smooth wall/ folds</li> <li>No enhancing solid tissue</li> </ul>
4	Intermediate Risk	~50% <sup>^</sup>	Lesion with solid tissue (excluding T2 dark/DWI dark) <ul style="list-style-type: none"> <li>Intermediate risk time intensity curve on DCE MRI</li> <li>If DCE MRI is not feasible, score 4 is any lesion with solid tissue (excluding T2 dark/DWI dark) that is enhancing ≤ myometrium at 30-40s on non-DCE MRI</li> </ul> Lesion with lipid content <ul style="list-style-type: none"> <li>Large volume enhancing solid tissue</li> </ul>
5	High Risk	~90% <sup>^</sup>	Lesion with solid tissue (excluding T2 dark/DWI dark) <ul style="list-style-type: none"> <li>High risk time intensity curve on DCE MRI</li> <li>If DCE MRI is not feasible, score 5 is any lesion with solid tissue (excluding T2 dark/DWI dark) that is enhancing &gt; myometrium at 30-40s on non-DCE MRI</li> </ul> Peritoneal, mesenteric or omental nodularity or irregular thickening with or without ascites

Figure (1): Image shows Ovarian-Adnexal Reporting and Data System (O-RADS) MRI risk stratification system.<sup>8</sup>

<i>Non-contrast MRI score</i>	Definition	MRI features
Score 1	No mass	No adnexal mass is demonstrated in pelvic MRI study
Score 2	Benign/likely benign	Radiologically characterized, has to have a radiological diagnosis (e.g. endometrioma, dermoid, fibroma)
Score 3	Indeterminate	Not classified in other scores. It may have a solid appearing component however this does not reach criteria for solid tissue*
Score 4	Suspicious for malignancy	Solid tissue criteria reached
Score 5	Highly suspicious for malignancy	Solid tissue criteria reached and presence of: • Peritoneal implants and/or • Lymphadenopathy and/or • Ascites in the presence of solid tissue, after benign diagnoses are excluded

*MRI magnetic resonance imaging*

\*Solid tissue is defined as tissue with intermediate signal intensity on T2-weighted imaging, low signal intensity on T1-weighted imaging and corresponding true diffusion restriction

Figure (2): Non-contrast MRI scoring system. <sup>7</sup>

**AIM OF THE WORK:**

Detection of the sensitivity and specificity of abbreviated non-contrast MRI study compared with contrast MRI study in evaluation of adnexal masses by using non-contrast and O-RADS scoring systems with detection of inter-reader agreement.

**PATIENTS AND METHODS:**

**Patients:**

This retrospective study included thirty patients with adnexal masses referred to MRI unit in Ain Shams University Hospitals. Their age ranged from 18 years to 78 years.

The study was conducted according to the stipulation of ASU ethical and scientific committee. Inclusion criteria were female patients with adnexal mass discovered by MRI or by ultrasound. Exclusion criteria were patients known to have contraindications for MRI, e.g., an implanted magnetic device and pacemakers, patients with high serum creatinine, low glomerular

filtration rate (GFR) and patients with history of allergic reactions.

**Methods:**

The MRI study was performed with a 1.5 T machine (Achieva Philips Healthcare). The patients imaged in supine position using a pelvic phased-array coil. MRI protocol included:

1. Sagittal, axial and coronal T2-weighted fast spin-echo sequences.
2. Axial T2-weighted fast spin-echo sequences with fat suppression.
3. Axial T1- weighted gradient-echo sequences.
4. Diffusion-weighted imaging (DWI).
5. Apparent diffusion coefficient (ADC) maps.
6. Axial, coronal and sagittal T1 post contrast images obtained after injection of 0.1ml / kg gadolinium.

Abbreviated non-contrast protocol included sequences from 1 to 5 in full protocol. Its duration time was 15 minutes while full protocol duration time was 33 minutes.

Four radiologists took part in image interpretation. Two radiologists assessed non-contrast MRI study by non-contrast MRI scoring system and the other two radiologists assessed contrast MRI study by Ovarian-Adnexal Reporting and Data System (O-RADS) MRI risk stratification system. The two radiologists who assessed non-contrast MRI study were blinded from contrast MRI sequences. All four radiologists were not aware of the results of each other. Comparison between Non-Contrast MRI and ORADS scoring system was done to interpret

sensitivity and specificity of non-contrast MRI study. Comparison between readers was done to interpret inter-reader agreement.

#### **Ethical Considerations:**

The study was conducted according to the stipulation of ASU ethical and scientific committee. It was a retrospective study. Data was collected from PACS system with complete confidentiality, and no one had right to read patient medical information except the main researchers.

#### **Cases:**

##### Case (1):

24 years old female patient presented by nausea and right iliac fossa pain of four days duration. Pelviabdominal ultrasound revealed right ovarian cyst with heterogeneous content.

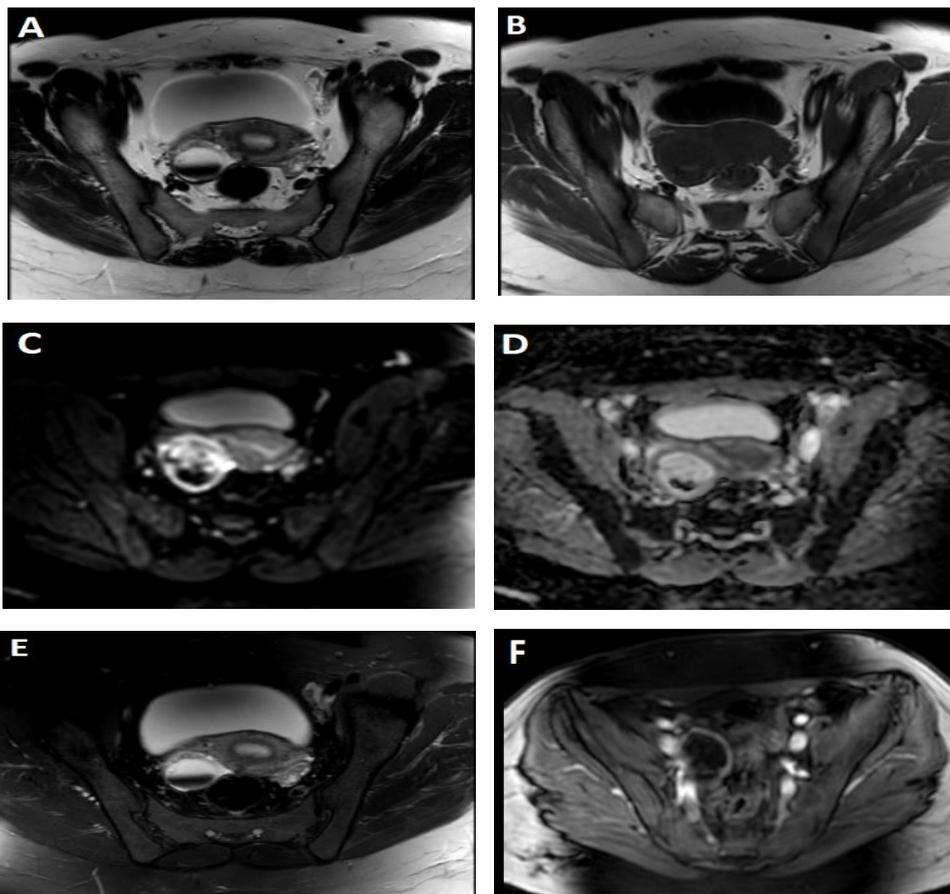


Figure (3): (A) Axial T2-weighted sequence showed right ovarian unilocular cystic lesion with fluid-fluid level. (B) Axial T1-weighted sequence showed a hypointense ovarian cyst. Both (C) DWI & (D) ADC maps showed internal foci of restricted diffusion. (E) Axial fat suppression T2WI revealed no fat suppression. (F) Contrast-enhanced axial T1WI showed thin wall enhancement of the cyst. O-RADS MRI score was 2, Non-Contrast MRI score was 2.

Case (2):

37 years old female patient known to have metastatic pancreatic cancer (multiple hepatic focal lesions). Tumor markers: CA125=19, CA19.9=10.

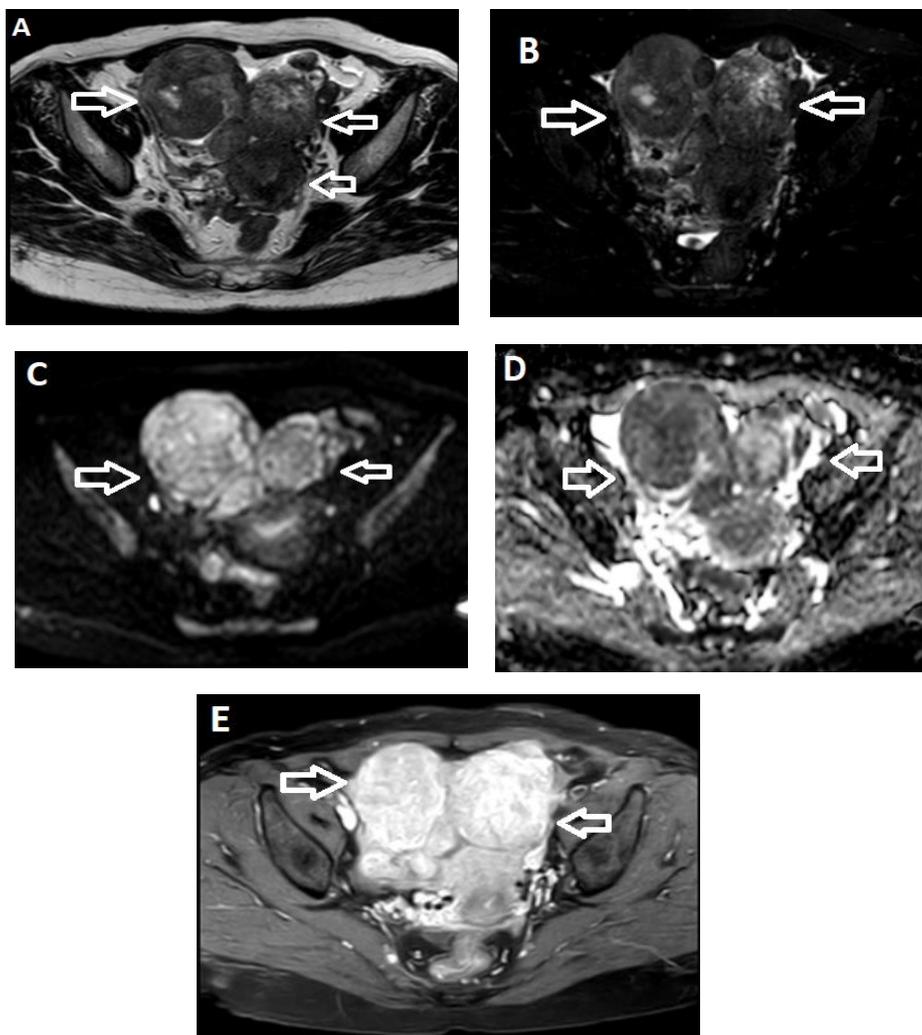


Figure (4): (A) Axial T2-weighted sequence showed bilateral ovarian solid masses (arrowed) with heterogeneous SI, ascites and LN enlargement. (B) Axial fat suppression T2 WI showed no fat suppression within ovarian masses (arrowed). (C) DWI & (D) ADC maps showed bilateral ovarian masses with true restricted diffusion (arrowed). (E) Contrast-enhanced axial T1WI showed intense heterogeneous enhancement of masses (arrowed) more than that of myometrium. O-RADS MRI score was 5 and Non-Contrast MRI was 5.

**RESULTS:**

In this retrospective study, 30 cases with adnexal masses were obtained from PACS system in MRI unit in Ain Shams University hospitals. The mean age of patients was 42 years (range from 18 years to 78 years).

This study was performed by 4 readers. Readers 1&3 assessed non-contrast MRI abbreviated protocol using non-contrast MRI scoring system. Readers 2&4 assessed contrast MRI full protocol using O-RADS.

Results of readers 2&4(O-RADS) were considered as the gold standard. Each reader reviewed MRI study images separately and blinded to history & other readers' interpretation.

Comparisons of results between reader 1 & reader 2 regarding descriptive findings were done. There was no statistically significant difference found between reader 1 & reader 2 in characterization of adnexal masses (**figure 5**).

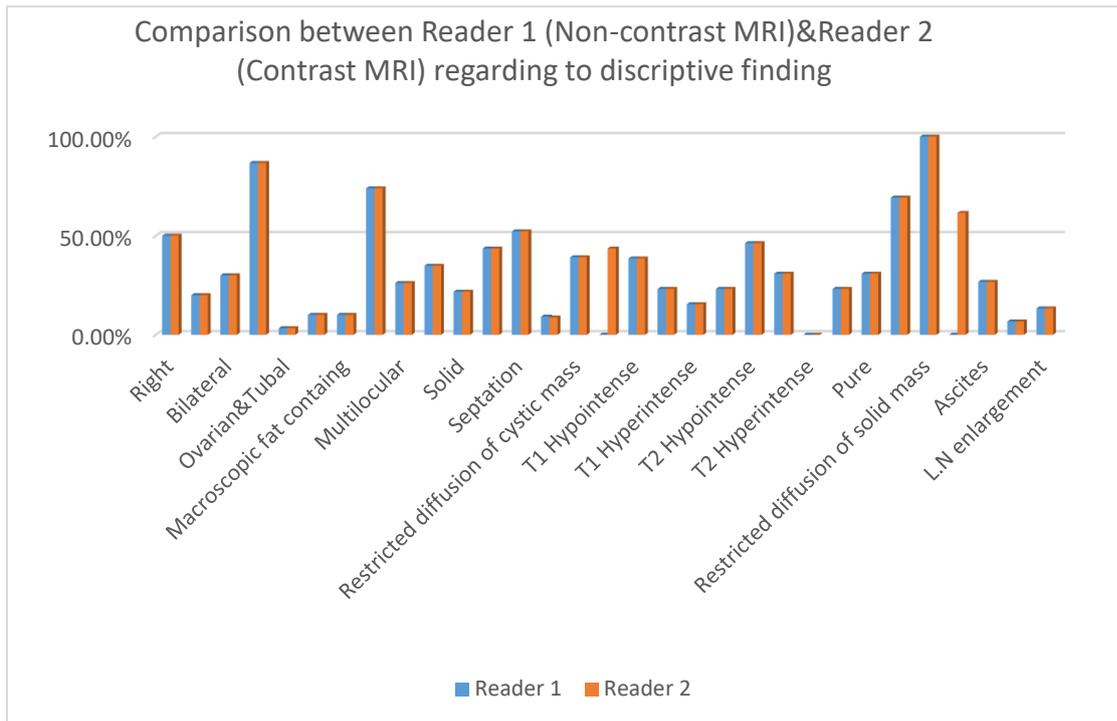


Figure (5): Comparison between (Reader 1) Non-Contrast MRI Scoring and (Reader 2) O-RADS regarding descriptive finding.

We considered (O-RADS) as the gold standard that was presented by the results of reader 2. The results of reader 1 non-contrast MRI (**Table 1**) for characterization of

adnexal masses found to have high specificity and high sensitivity. We excluded borderline tumors to improve accuracy.

Table (1): Reader 1 on reader 2 and reader 2 is the gold standard.

Final outcome		Final outcome (Contrast MRI)		TP	TN	FP	FN	Accuracy	Sensitivity	Specificity	PPV	NPV
		Benign	Malignant									
		No. = 13	No. = 7									
Non contrast MRI	Benign	12 (92.3%)	0 (0.0%)	7	12	1	0	95.0%	100.0%	92.3%	87.5%	100.0%
	Malignant	1 (7.7%)	7 (100.0%)									

Chi-square test= 16.154 P-value <0.001 (HS) P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value<0.01: highly significant (HS) \*: Chi-square test

Results of reader (3) were compared with those of reader (4) regarding descriptive findings. There was no statistically

significant difference found between reader 3 & reader 4 in characterization of adnexal masses (**figure 6**).

**Efficacy Of Non-Contrast Mri Studies In Characterization Of Adnexal Masses Compared To..**

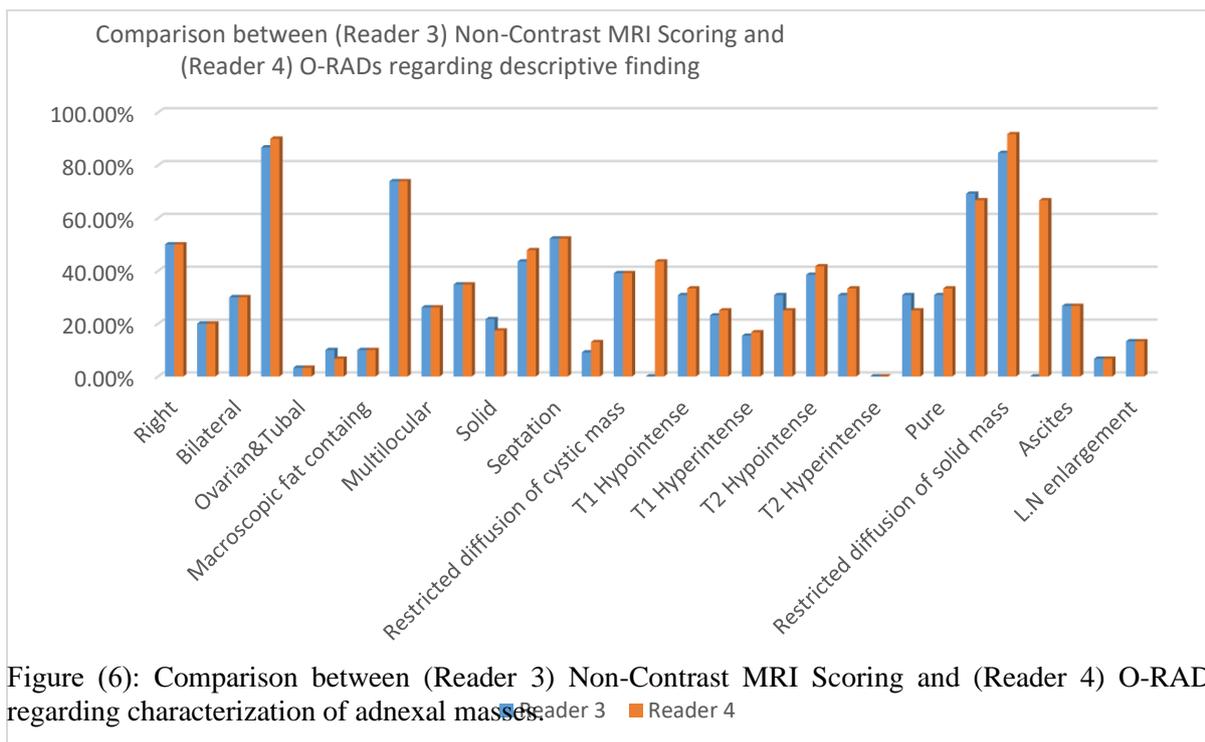


Figure (6): Comparison between (Reader 3) Non-Contrast MRI Scoring and (Reader 4) O-RADS regarding characterization of adnexal masses. Reader 3 (blue) Reader 4 (orange)

We considered (O-RADS) as the gold standard that was presented by the results of reader 4. The results of reader 3 non-contrast MRI (**Table 2**) for characterization of

adnexal masses found to have high specificity and high sensitivity. Also, we excluded borderline tumors to improve accuracy.

**Table (2):** Reader 3 on reader 4 and reader 4 is the gold standard.

Final outcome		Final outcome (Contrast MRI)		TP	TN	FP	FN	Accuracy	Sensitivity	Specificity	PPV	NPV
		Benign	Malignant									
		No. = 13	No. = 7									
Non contrast MRI	Benign	13 (100.0%)	0 (0.0%)	7	13	0	0	100.0%	100.0%	100.0%	100%	100%
	Malignant	0 (0.0%)	7 (100.0%)									

Chi-square test= 20.000 P-value <0.001 (HS) P-value >0.05: Non significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS) \*: Chi-square test

Comparison between results of reader (1) with reader (3) regarding non-contrast MRI scoring system and reader (2) with reader (4)

regarding O-RADS were done and showed high inter-reader agreement (**Figures 7 & 8**).

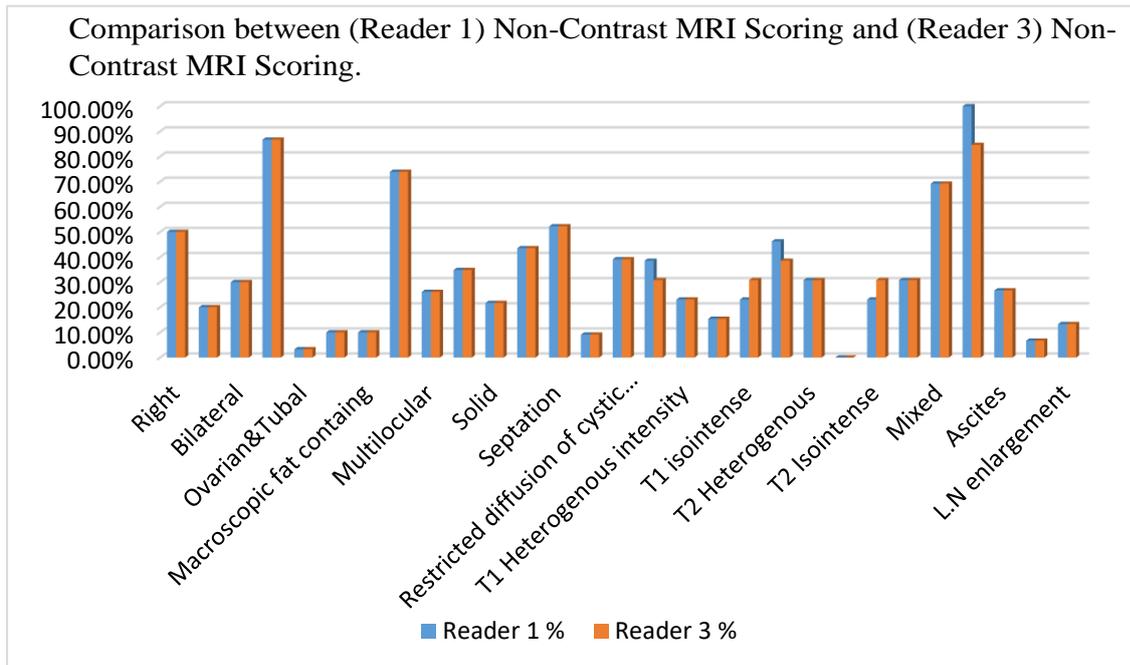


Figure (7): Comparison between (Reader 1) and (Reader 3) regarding Non-Contrast MRI Scoring.

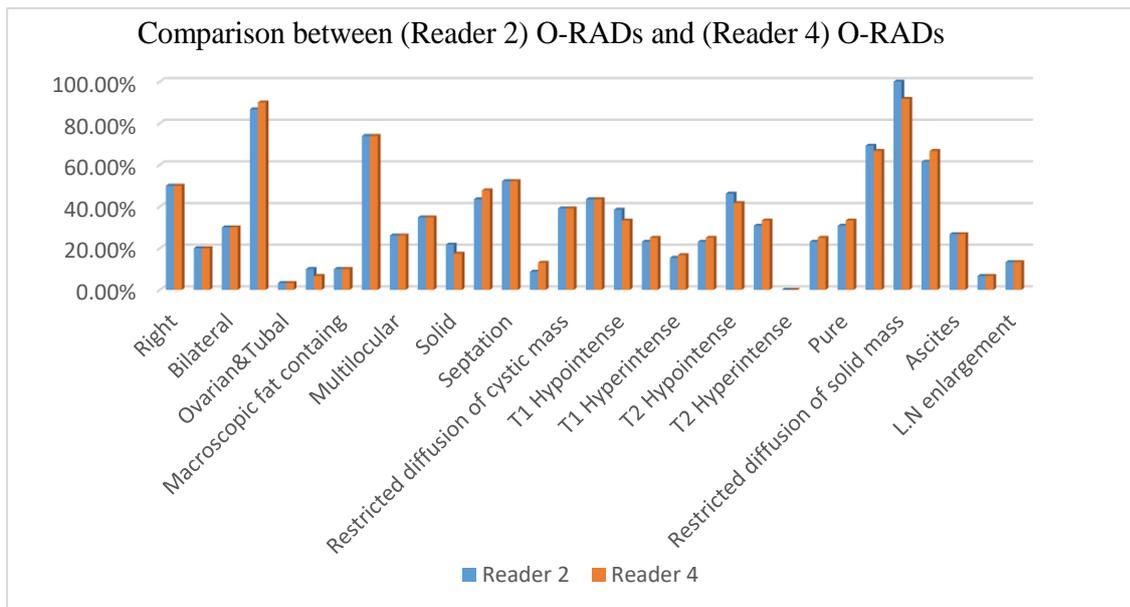


Figure (8): Comparison between (Reader 2) and (Reader 4) regarding O-RADs.

**DISCUSSION:**

Adnexal masses are common disease in the female genital system. Ovarian cancer is the most silent and deadly gynecological malignancies, because of the lack of clear symptoms and signs until its advanced stages<sup>9</sup>. Magnetic Resonance Imaging (MRI)

is an essential problem-solving tool to determine the site of origin of a pelvic mass and then to characterize an adnexal mass, especially in patients with indeterminate lesion<sup>10</sup>. Non-Contrast MRI suggests benign masses by low signal intensity within solid tissue (less than skeletal muscle) on T2-

weighted imaging and DWI. Macroscopic fat was diagnostic of benign mature teratoma. Hemorrhagic cyst was seen as hyperintense on both T1W and T2W. Simple cyst was seen as hypointense on T1W and hyperintense on T2W. Hydrosalpinx was seen as hypointense on T1W and hyperintense with incomplete septa on T2W. Fibroid was seen as hypointense on T2W and isointense on T1W compared to the myometrium. Malignant masses were suggested by increased size of the lesion, increased wall thickness, mixed cystic and solid configuration, papillary projections, intermediate to high signal intensity on T2-weighted imaging and presence of ascites and peritoneal deposits.<sup>11</sup>

Our study aimed to evaluate the specificity and sensitivity of characterizing adnexal masses using a non-contrast MRI protocol to find out the substitute of the contrast use in MRI protocol for people who has contraindications of contrast administration such as high serum creatinine, low glomerular filtration rate and history of allergic reactions. Furthermore, it increases the total cost and time of the study.<sup>12</sup>

Results of our study indicate that Non-Contrast MRI protocol can correctly classify adnexal masses into benign or malignant. Results of reader 1 (Non-Contrast MRI) compared with results of reader 2 (O-RADS) showed high specificity (92.3%), high sensitivity (100%) and high accuracy (95%). Also, results of reader 3 (Non-Contrast MRI) compared with reader 4 (O-RADS) showed 100% specificity, sensitivity and accuracy. All readers were blinded from the results of each other. These results agree with a study by Sahin et al. (2021) in United Kingdom in which Non-Contrast MRI Scoring System achieved 84.9% sensitivity, 95.9% specificity and 94% accuracy. Although, the results of our study had a high specificity, sensitivity and accuracy, Contrast MRI could differentiate soft tissue component and papillary projections better than Non-Contrast MRI.

In statistics, inter-reader agreement is the degree of agreement among independent observers who assess the same phenomenon. Assessment tools that rely on rating must exhibit good inter-reader agreement otherwise they are not valid tests. In our study, there was an inter-reader agreement with high reproducibility and repeatability of the score. All readers were not aware of the result of each other. This agrees with a study by Sahin et al. (2021) in United Kingdom in which the agreement rates were over 95%. Also, the study of Thomassin-Naggara et al. (2020) in United States showed inter-reader agreement rates were 95%.

#### ***Recommendations:***

Doing further studies with larger sample size, including borderline lesions, follow up of cases and comparing results of O-RADS and non-contrast MRI scoring system with histopathology as gold standard.

#### ***Conclusion:***

Non-Contrast MRI has high accuracy and excellent inter-reader agreement for characterization of adnexal masses. So, Non-Contrast MRI can be a safe alternative method when contrast use is contraindicated. It can save time, decrease the total cost of the study and avoid side effects of contrast.

#### ***Conflict of Interest:***

The authors declared that they had no conflict of interest.

#### ***List of Abbreviations:***

ADC: Apparent Diffusion Coefficient.  
ASU: Ain Shams University.  
DWI: Diffusion-Weighted Imaging.  
GBCAs: Gadolinium-based contrast agent.  
GFR: Glomerular Filtration Rate.  
MRI: Magnetic Resonance Imaging.  
O-RADS: Ovarian-Adnexal Reporting and Data System.  
PACS: Picture Archiving and Communication System.  
WI: Weighted Imaging.

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## فعالية الرنين المغناطيسي بدون صبغة في توصيف كتل ملحقات الرحم مقارنة بالرنين المغناطيسي بالصبغة

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**مقدمة:** تعد كتل ملحقات الرحم مشكلة شائعة في أمراض النساء. معظم هذه الكتل تكون حميدة (غير سرطانية) وقد تكون خبيثة (سرطانية). فالتقييم المناسب قبل الجراحة يساعد على التفرقة بين الحميدة والخبيثة في توجيه أطباء أمراض النساء في إحالة النساء المصابات بأورام خبيثة مشتبه بها إلى أخصائي أورام أمراض النساء للحصول على العلاج المناسب. يتم التفريق بين الأورام الخبيثة و الحميدة بالرنين المغناطيسي بالصبغة باستخدام نظام التصنيف ال O-RADS، وبالرنين المغناطيسي بدون صبغة باستخدام نظام تصنيف بسيط مكون من ٥ نقاط. التصوير بالرنين المغناطيسي باستخدام الصبغة لديه دقة عالية في تشخيص كتل ملحقات الرحم الحميدة والخبيثة. ولكن هناك مخاوف إعطاء صبغة الجادولينيوم وذلك لتأثيرها على الجهاز الكلى والتأثير المحتمل لاحتباس الجادولينيوم في الأنسجة والأعضاء. التصوير بالرنين المغناطيسي بدون صبغة يستطيع توفير الوقت وتقليل التكلفة وتجنب الآثار الجانبية للصبغة وقد يكون بديلاً مناسباً للتشخيص عندما يكون استخدام الصبغة غير ممكن. تقوم هذه الدراسة على مقارنة نتائج الرنين المغناطيسي بدون صبغة مع نتائج الرنين المغناطيسي بالصبغة.

**الهدف من البحث:** مقارنة كفاءة التصوير بالرنين المغناطيسي بدون صبغة والتصوير بالصبغة في توصيف كتل ملحقات الرحم الحميدة والخبيثة.

**طريقة البحث:** تتضمن الدراسة ثلاثين سيدة بوحدة الرنين المغناطيسي تعاني من كتل ملحقات الرحم. وقد أجريت هذه الدراسة وفق اشتراطات لجنة أخلاقيات البحث العلم بجامعة عين شمس مع ضمان خصوصية المشاركين وسرية البيانات خلال مراحل الدراسة المختلفة. تتضمن هذه الدراسة إجراء رنين مغناطيسي بدون صبغة وباستخدام صبغة.

**النتائج:** لا يوجد فرق ملحوظ بين نتائج اشعة الرنين بالصبغة وبدون استخدام الصبغة وكذلك لا يوجد فرق ملحوظ بين نتائج تقارير أطباء الأشعة.

**الخلاصة:** التصوير بالرنين المغناطيسي بدون صبغة يوفر بديلاً تشخيصياً معقولاً عندما يكون إعطاء الصبغة غير ممكن. كما أنه يساعد على توفير الوقت وتقليل التكلفة الإجمالية للدراسة وتجنب الآثار الجانبية للصبغة.