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

Sarah Solaiman Roshdy, Ahmed Mohamed Monib, Asmaa Magdy Salama, Sherihan S. Madkour

ABSTRACT:

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.

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.¹
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.1,3

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.4

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.5,6

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.7

<table>
<thead>
<tr>
<th>O-RADS MRI Risk Stratification and Management System</th>
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<tbody>
<tr>
<td>O-RADS MRI Score</td>
</tr>
<tr>
<td>0 Incomplete Evaluation</td>
</tr>
<tr>
<td>1 Normal Ovaries</td>
</tr>
<tr>
<td>2 Almost Certainty Benign</td>
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<td></td>
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<td></td>
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<td></td>
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<tr>
<td>3 Low Risk</td>
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<tr>
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<tr>
<td>4 Intermediate Risk</td>
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<td>5 High Risk</td>
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</table>

Figure (1): Image shows Ovarian-Adnexal Reporting and Data System (O-RADS) MRI risk stratification system.8
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):](image)

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.
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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).
Comparison between Reader 1 (Non-contrast MRI)&Reader 2 (Contrast MRI) regarding to descriptive finding

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.

<table>
<thead>
<tr>
<th>Final outcome</th>
<th>Final outcome (Contrast MRI)</th>
<th>4L</th>
<th>4H</th>
<th>FN</th>
<th>Accuracy</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-contrast MRI</td>
<td>Benign</td>
<td>12 (92.3%)</td>
<td>0 (0.0%)</td>
<td>7</td>
<td>95.0%</td>
<td>100.0%</td>
<td>92.3%</td>
<td>87.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Malignant</td>
<td>1 (7.7%)</td>
<td>7 (100.0%)</td>
<td>7</td>
<td>100.0%</td>
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</tbody>
</table>

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).
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![Comparison between (Reader 3) Non-Contrast MRI Scoring and (Reader 4) O-RADs regarding descriptive finding](image)

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.

<table>
<thead>
<tr>
<th>Final outcome</th>
<th>Final outcome (Contrast MRI)</th>
<th>dL</th>
<th>dH</th>
<th>dN</th>
<th>Accuracy</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Add</th>
<th>MN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benign</strong></td>
<td>Non contrast MRI</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. = 13</td>
<td></td>
<td>13 (100.0%)</td>
<td>0 (0.0%)</td>
<td>7</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>Malignant</strong></td>
<td></td>
<td>0 (0.0%)</td>
<td>7 (100.0%)</td>
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</table>

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).
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 stages⁹. 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 lesion¹⁰. Non-Contrast MRI suggests benign masses by low signal intensity within solid tissue (less than skeletal muscle) on T2-
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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. Hydrocelal 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.11

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.12

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.
REFERENCES:


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