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# Diagnostic Accuracy of MRI in Diagnosing Malignant Adnexal Masses, taking Histopathology as the Gold Standard

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## ABSTRACT

**Objective:** This study aims to evaluate the diagnostic accuracy of Magnetic Resonance Imaging (MRI) in identifying complicated adnexal masses, using histopathology as the reference standard. **Methods:** Conducted at the Department of Radiology, Bahawal Victoria Hospital in Bahawalpur, between March 2024 and September 2024, this cross-sectional study involved performing both MRI and histopathological evaluations on patients with adnexal masses. The histopathology results served as the gold standard for comparison with MRI findings. Data analysis was performed using SPSS version 20. **Results:** The study participants had an average age of 31.2 ± 15.5 years. MRI demonstrated a sensitivity of 97.1% and a specificity of 87.2% in diagnosing complicated adnexal masses. **Conclusion:** Contrast-Enhanced MRI is a highly reliable and accurate diagnostic tool for evaluating complicated adnexal masses. Its high sensitivity and specificity make it a valuable complement to histopathology in the diagnostic process.

## INTRODUCTION

Ovarian tumors make up about two-thirds of these cases. Ovarian cancer is the seventh most commonly diagnosed cancer in women globally, with epithelial ovarian cancer being the most common type. Ovarian cancers are among the most lethal gynecological cancers due to their tendency to be diagnosed at a late stage and their generally poor response to treatment [1-3]. Radiologists face the challenge of distinguishing between benign and malignant adnexal lesions to guide treatment. Often, it's only clear after surgical exploration and histology. Ovarian masses are found in 7.8% of pre-menopausal and 2.5% of post-menopausal women [4-6].

Evaluating adnexal masses involves patient history and tests such as 3D ultrasonography, Doppler imaging, CT, and MRI, along with tumor markers like alpha-fetoprotein, CA-125, and CA19.9 [7]. A definitive diagnosis requires histopathology. Ultrasound is typically the first imaging method used. Evaluation also considers family history of breast cancer and BRCA 1 or 2 mutations. A local study found 46% of adnexal masses were cancerous, and Doppler ultrasound couldn't definitively classify up to 20% of complex masses. While gray-scale and Doppler ultrasounds are sensitive and cost-effective, they sometimes struggle to distinguish malignant from benign masses [8, 9]. Features suggesting malignancy include solid components, papillary projections, complex solid or cystic masses, and thick septations. Additional signs are involvement of the mesentery, peritoneum, or omentum, lymphadenopathy, and invasion of the pelvic sidewall. MRI features strongly indicating malignancy are papillary projections in a cystic lesion, ascites, a diameter over 6 cm, and degeneration in a solid lesion [12, 13].

Previous studies show varied sensitivity and specificity for Doppler ultrasound and CT, around 80% and 52%, respectively, though these methods sometimes miss lesion origins. This study aims to evaluate MRI's diagnostic accuracy for complex adnexal masses compared to Doppler studies. MRI, with its superior soft

tissue differentiation and multi-sequential imaging, is increasingly used. We aim to assess MRI's accuracy against Doppler studies, using histopathology as the gold standard.

## MATERIAL AND METHODS

A cross-sectional study was conducted at the Department of Radiology, Bahawal Victoria Hospital in Bahawalpur from March to September 2024, following approval from the Ethical Committee. The study included a sample of 120 patients, with a 95% confidence interval and a 0.05% margin of error. The prevalence of general adnexal masses identified through Doppler studies was accepted to be 20%, and the diagnostic accuracy of MRI was found to be 94.83% sensitivity and 87.50% specificity. The sampling technique used was non-random consecutive sampling.

### Inclusion Criteria

1. Patients aged between 20 and 75 years.
2. Adnexal masses identified on ultrasonography.
3. Heterogeneous, complex, or inconclusive findings on Doppler studies.

### Exclusion Criteria

1. Patients with previously removed adnexal masses.
2. Contraindications for MRI (e.g., metal implants, renal failure).
3. Any chronic condition such as chronic renal failure or chronic liver disease.
4. Patients with another known malignancy.

Following approval from the hospital's ethical committee, 120 patients meeting the inclusion criteria and excluding those with any of the listed confounding factors were enrolled in the study at Bahawal Victoria Hospital, Bahawalpur. Comprehensive and accurate histories were collected from all participants. Each patient underwent Doppler studies using the Logiq S8 with a 2-7 MHz probe. Subsequently, MRI was performed on each patient using a GE HDX 1.5 Tesla MRI machine with CTL coils and MRI gradients. All data, along with demographic variables, were recorded in a designated proforma. The researcher conducted the reporting under the supervision of a senior radiologist. Data analysis was performed using SPSS Version 20. Qualitative data, such as the characterization of masses (benign vs. malignant) on MRI and histopathology, were presented as frequencies and percentages.

## RESULTS

A total of 120 cases were included in this study. The average age of the patients was 31 ± 1.5 years, with ages ranging from 18 to 75 years. In this study, MRI identified malignant adnexal masses in 69 patients (57%) and benign adnexal masses in 47 patients (39%), as detailed in Table 1.

**Table 1**

*MRI findings x histopathology crosstabulation.*

| | | Histopathology | | Total |
|---|---|---|---|---|
| | | Benign | Malignant | |
| MRI findings | Benign | 41 | 6 | 47 |
| | Malignant | 2 | 67 | 69 |
| | Equivocal | 2 | 2 | 4 |
| Total | | 45 | 75 | 120 |

Sensitivity = TP / (TP + FN) = 67 / (67 + 2) ≈ 0.971
Specificity = TN / (TN + FP) = 41 / (41 + 6) ≈ 0.872
PPV = TP / (TP + FP) = 67 / (67 + 6) ≈ 0.918
NPV = TN / (TN + FN) = 41 / (41 + 2) ≈ 0.953
Sensitivity: 97.1%
Specificity: 87.2%
PPV: 91.8%
NPV: 95.3

The table presents data on MRI findings compared to histopathology results for 120 cases. It indicates that there were 47 cases where both the MRI and histopathology agreed on benign findings, 67 cases where both indicated malignancy, and 4 cases with equivocal MRI results. Specifically, among the 47 benign MRI findings, 41 were confirmed as benign by histopathology (True Negatives), and 6 were actually malignant (False Positives). This results in a specificity of approximately 87.2%. For the 69 malignant MRI findings, 67 were confirmed as malignant by histopathology (True Positives), and 2 were benign (False Negatives), leading to a sensitivity of approximately 97.1%. The table shows that the MRI has a PPV of about 91.8% and a NPV of approximately 95.3). These percentages reflect the MRI's effectiveness in identifying malignancies and benign conditions.

The comparison of MRI with histopathology for diagnosing complex adnexal masses, stratified by age, is shown in Table 2.

**Table 2**

*MRI findings and patient age cross tabulation*

| | | Patient age | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | 10-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | |
| MRI findings | Benign | 10 | 12 | 16 | 7 | 0 | 0 | 2 | 47 |
| | Malignant | 9 | 14 | 15 | 15 | 8 | 5 | 3 | 69 |
| | Equivocal | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 4 |
| | Total | 19 | 27 | 31 | 22 | 11 | 5 | 5 | 120 |

Histopathology for diagnosing complex adnexal masses stratified by age is represented in Table 3.

**Table 3**

*Histopathology x patient age cross-tabulation.*

| | | Patient age | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | 10-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | |
| Histopathology | Benign | 8 | 11 | 16 | 6 | 2 | 0 | 2 | 45 |
| | Malignant | 11 | 16 | 15 | 16 | 9 | 5 | 3 | 75 |
| | Total | 19 | 27 | 31 | 22 | 11 | 5 | 5 | 120 |

FP = Total Malignant - TP = 69 - 15 = 54
TN = Total Benign - FN = 47 - 16 = 31
Sensitivity = TP / (TP + FN) = 15 / (15 + 16) ≈ 0.48 or 48%

Specificity = TN / (TN + FP) = 31 / (31 + 54) ≈ 0.36 or 36%
PPV = TP / (TP + FP) = 15 / (15 + 54) ≈ 0.22 or 22%
NPV = TN / (TN + FN) = 31 / (31 + 16) ≈ 0.66 or 66%

Tables 2 and 3 provide a detailed breakdown of complex adnexal masses diagnosed by MRI and histopathology across different age groups. Table 3 shows that MRI findings are categorized as 47 benign, 69 malignant, and 4 equivocal cases, with benign cases most common in the 31-40 age group and malignant cases distributed more evenly, peaking in the 31-40 and 41-50 age groups. Table 4 confirms 45 benign and 75 malignant histopathology results, with a similar age distribution pattern. The diagnostic performance of the MRI reveals a sensitivity of 48%, specificity of 36%, PPV of 22%, and NPV of 66%, indicating moderate sensitivity, low specificity, and better accuracy in identifying non-malignant cases.

A young female patient pelvis showing bilateral solid cystic adnexal masses which proved to be mucinous cystadenomata on histopathology.

**Figure 1**
*MRI pelvic T1 post contrast image showing solid cystic adnexal mas showing enhancement of theid component.*

## DISCUSSION

This cross-sectional study aimed to assess the diagnostic accuracy of Dynamic MRI for identifying complex adnexal masses that were inconclusive on Doppler ultrasound, using histopathology as the gold standard. Accurate diagnosis of adnexal masses is essential, particularly for pre-menopausal and postmenopausal women, to prevent unnecessary surgeries and to facilitate conservative treatment approaches that help preserve reproductive potential. For instance, in cases of benign cystic lesions, ultrasound-guided aspiration can avoid multiple surgeries, which is especially beneficial for women of childbearing age to prevent complications like adhesions and infertility.

Adnexal malignancies, are serious gynecological tumors with high recurrence rates and poor survival outcomes. They are often diagnosed at advanced stages, contributing to a low 5-year survival rate. However, early detection significantly improves outcomes, with the 5-year overall survival rate exceeding 90%. For example, borderline ovarian tumors (BOTs) have a 5-year survival rate of 95% [13].

The diagnostic performance of MRI in our study is consistent with previous research, demonstrating higher sensitivity, specificity, and accuracy compared to Trans-Abdominal Doppler Ultrasonography and Contrast-Enhanced Computed Tomography (CT) scans. For instance, a similar study reported MRI sensitivity at 92.68% and specificity at 73.68%. With an overall diagnosis accuracy of 86.66%, the PPV and NPV were almost 88.37% and 82.35%, respectively. Furthermore, with a correlation value of 0.685, the relationship between the results of histology and MRI was statistically significant ($p<0.05$) [14]. Research conducted at various institutions has emphasized the effectiveness of ultrasonography, color Doppler tests, and MRI in differentiating between benign and malignant adnexal masses, as well as in characterizing the origin and tissue properties of these masses. MRI has proven to be a particularly valuable tool for evaluating pelvic masses, offering enhanced capability in identifying local invasion and improving both sensitivity and specificity, especially when used with contrast enhancement [15].

## CONCLUSION

This study confirms that MRI is an invaluable tool for diagnosing complex adnexal masses, demonstrating high sensitivity, specificity, and diagnostic accuracy, which serves as the gold standard. MRI provides essential diagnostic insights, revealing that masses with benign features are generally non-cancerous, while those with malignant features are often confirmed as malignant on histopathology. No distinct pattern of malignancy distribution across different age groups was observed. Accurate MRI diagnosis facilitates effective treatment planning and can help reduce unnecessary surgical interventions, especially in younger women.

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