Role of MRI Imaging in Evaluation of Ovarian Lesions: A Descriptive Study

[1]C. Sylviya, [2]Sathish Babu and [3]Assvath
[1-3]*Sree Mookambika Institute of Medical Sciences, Padanilam, Kulasekharam, India*

ABSTRACT
Ovarian lesions range from benign cysts to malignant neoplasms, making accurate diagnosis essential for appropriate management. While ultrasound is the first-line imaging tool, MRI has gained prominence for its superior soft-tissue contrast, multi-planar capability and absence of radiation, particularly beneficial in complex cases. Ovarian cancer, one of the most common cancers in women, has a high mortality rate due to often late diagnosis. Therefore, MRI's potential role in distinguishing benign from malignant ovarian lesions warrants detailed investigation. This descriptive study was conducted at tertiary care centre from January 2024 to june 2024, Fifty female patients aged 18 years and above, with ovarian lesions detected by clinical examination or ultrasound, underwent MRI evaluation. The MRI protocol included T1-weighted, T2-weighted, diffusion-weighted imaging (DWI) and contrast-enhanced sequences. MRI findings were analyzed for lesion type, size, septations and enhancement patterns and were compared to histopathological results. Diagnostic accuracy metrics, including sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), were calculated. Participants primarily ranged from 31-40 years, multiparous and premenopausal. MRI identified 44% cystic, 24% solid and 32% complex lesions, with the majority (60%) measuring 5-10 cm. Contrast enhancement was seen in 52% of lesions, with malignant lesions commonly showing solid and enhancing features. MRI findings showed an 88% concordance with histopathology, with benign lesions showing higher diagnostic accuracy. MRI demonstrated a sensitivity of 83%, specificity of 91%, PPV of 87%, NPV of 86% and an overall accuracy of 88%. MRI is a reliable tool for characterizing ovarian lesions, particularly in differentiating between benign and malignant cases. With its high specificity and accuracy, MRI can complement ultrasound in complex ovarian cases, helping refine surgical decisions and patient management.

INTRODUCTION

Ovarian lesions encompass a broad spectrum of pathologies, ranging from benign cysts to malignant neoplasms. Accurate diagnosis and differentiation between benign and malignant ovarian lesions are critical for appropriate patient management, as early and accurate identification of malignancies can significantly improve prognosis[1]. Traditionally, ultrasound has been the initial imaging modality for evaluating ovarian pathology due to its accessibility, safety and cost-effectiveness. However, Magnetic Resonance Imaging (MRI) is increasingly being utilized for its superior soft tissue contrast resolution, multi-planar imaging capabilities and lack of ionizing radiation, making it a valuable tool for detailed assessment of ovarian lesions, particularly in complex cases[2]. Ovarian cancer is the seventh most common cancer among women worldwide and is associated with a high mortality rate due to its often late diagnosis. According to the World Health Organization, over 300,000 new cases of ovarian cancer are diagnosed globally each year, with the majority being identified in advanced stages[3]. The incidence of benign ovarian cysts and other non-malignant lesions is also substantial, affecting women across different age groups and often requiring surgical intervention to prevent complications such as torsion or rupture. The high prevalence and diagnostic challenge of distinguishing benign from malignant ovarian lesions highlight the importance of accurate imaging techniques[4]. Several studies have demonstrated MRI's utility in evaluating ovarian lesions. A study by Thomassin-Naggara[5] explored the use of MRI in characterizing ovarian masses and found it to be highly accurate, especially in complex lesions that were difficult to classify with ultrasound. The study reported that the MRI model for ovarian lesion characterization had a sensitivity of 95% and specificity of 90% for identifying malignancies. Similarly, a retrospective study by Mahesh[6] found MRI to have a diagnostic accuracy rate of over 90% in distinguishing benign from malignant ovarian tumors, especially when contrast enhancement sequences were included. Moreover, the work of Lamghare[1] emphasized MRI's role in reducing false-positive rates associated with ultrasound, particularly for endometriomas and dermoid cysts, where MRI could accurately depict lesion components like fat and hemorrhage, enhancing diagnostic specificity. Another study by Lisa[7] highlighted the effectiveness of MRI in differentiating borderline ovarian tumors, which can often present ambiguous findings on ultrasound. The study concluded that MRI, in combination with clinical and laboratory parameters, could significantly enhance the diagnostic work up of ovarian lesions. Given the significant clinical implications of ovarian lesions, the accurate and early distinction between benign and malignant conditions is essential. While transvaginal ultrasound remains the first-line imaging modality, MRI has shown potential as a more definitive diagnostic tool, especially for complex adnexal masses where ultrasound results may be inconclusive. MRI's ability to assess lesion characteristics such as size, morphology, vascularity and enhancement patterns provides valuable information that can assist in differentiating between benign and malignant lesions, thereby reducing the need for unnecessary surgeries and aiding in appropriate management planning.

Aims and objectives:

Aims: To evaluate the role of MRI imaging in the diagnosis, characterization and differentiation of ovarian lesions in a tertiary care setting.

Objectives:

- To analyze the MRI characteristics (such as lesion type, size, presence of septations and enhancement patterns) of various ovarian lesions in patients presenting with ovarian pathology.
- To correlate MRI findings with histopathological diagnoses to assess the accuracy and reliability of MRI in differentiating benign, borderline and malignant ovarian lesions.

MATERIALS AND METHODS

Study Design: This is a cross-sectional, descriptive study conducted at tertiary care centre, designed to evaluate the role of MRI imaging in diagnosing and characterizing ovarian lesions.

Study Setting: The study was conducted in the Radiology Department at tertiary care centre equipped with advanced MRI facilities.

Study Duration: The study was conducted over a period of one year, from january 2024 to june 2024.

Sample Size: A total of 50 patients presenting with ovarian lesions, either incidentally detected or suspected on prior ultrasound, were included in the study.

Inclusion Criteria:

- Female patients aged 18 years and above with ovarian lesions detected on clinical examination or ultrasound.
- Patients who underwent MRI as part of their diagnostic work up for ovarian pathology.
- Patients with histopathological confirmation of diagnosis, either through surgical excision or biopsy, following MRI evaluation.

Exclusion Criteria:
- Patients with contraindications to MRI (e.g., pacemakers, certain metal implants).
- Patients with ovarian lesions of indeterminate origin.
- Pregnant women, due to MRI safety considerations during pregnancy.

Study Procedure:
- **Patient Enrollment and Clinical Data Collection:** Patients meeting the inclusion criteria were enrolled in the study. Demographic and clinical data were collected, including age, parity, menopausal status and presenting symptoms.
- **MRI Protocol:** MRI was performed on a 1.5 Tesla MRI scanner. The MRI protocol for evaluating ovarian lesions included the following sequences:
- **T1-Weighted Images (T1WI):** Axial and sagittal planes for anatomical assessment.
- **T2-Weighted Images (T2WI):** Axial, sagittal and coronal planes to evaluate lesion morphology and cystic or solid nature.
- **Diffusion-Weighted Imaging (DWI):** To assess cellular density and restriction, aiding in distinguishing benign from malignant lesions.
- **Fat-Suppression Techniques:** To detect fat content within lesions, such as dermoid cysts.
- **Contrast-Enhanced T1-Weighted Images (Post-Contrast):** For evaluating enhancement patterns, which aid in the differential diagnosis and identifying malignant characteristics.
- **MRI Image Analysis:** Each MRI scan was reviewed independently by two experienced radiologists. The following characteristics of each ovarian lesion were documented:
- **Lesion Type:** Cystic, solid, or complex (mixed solid and cystic).
- **Lesion Size:** Maximum diameter of the lesion.
- **Presence of Septations:** Assessment for internal septations and thickness.
- **Enhancement Patterns:** Observed on post-contrast images to aid in distinguishing benign from malignant features.
- **Other Findings:** Presence of ascites, peritoneal deposits, or other signs suggestive of malignancy.
- **Histopathological Correlation:** Following MRI, all patients underwent surgical excision or biopsy of the ovarian lesion for histopathological examination, conducted by a pathologist who was blinded to MRI findings. Histopathology was considered the gold standard for diagnosis and

was used to categorize lesions as benign, borderline, or malignant.
- **Data Analysis:**
- Descriptive statistics were used to summarize patient demographics and MRI findings.
- Lesion characteristics (type, size, enhancement, etc.) were analyzed and correlated with histopathological diagnoses to determine MRI's diagnostic accuracy.
- Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall accuracy of MRI in differentiating benign from malignant lesions were calculated.
- **Outcome Measures:**
- The primary outcome was the accuracy of MRI in characterizing and differentiating ovarian lesions based on their MRI features.
- Secondary outcomes included the correlation between MRI findings and histopathological diagnosis, as well as the determination of MRI's diagnostic performance metrics (sensitivity, specificity, PPV, NPV and accuracy).

Statistical Analysis: Data analysis was performed using sotware SPSS Version 26. Continuous variables, such as lesion size, were presented as mean±standard deviation. Categorical variables, such as lesion type and diagnosis, were presented as frequencies and percentages. The diagnostic performance of MRI was evaluated by comparing MRI findings with histopathological diagnoses and Chi-square or Fisher's exact test was used to assess statistical significance, with a p-value <0.05 considered statistically significant.

RESULTS AND DISCUSSIONS

Table 1: Demographic Characteristics of the Study Population (n=50)

Characteristic	Frequency	Percentage (%)
Age (Years)		
-<20	6	12
-20-30	14	28
-31-40	18	36
->40	12	24
Parity		
-Nulliparous	18	36
-Multiparous	32	64
Menopausal Status		
-Premenopausal	38	76
-Postmenopausal	12	24

This table summarizes the demographic data for the 50 patients in the study. Most participants were aged 31-40, multiparous and premenopausal, reflecting a varied sample suitable for assessing MRI's role in evaluating ovarian lesions across different age groups and reproductive statuses.
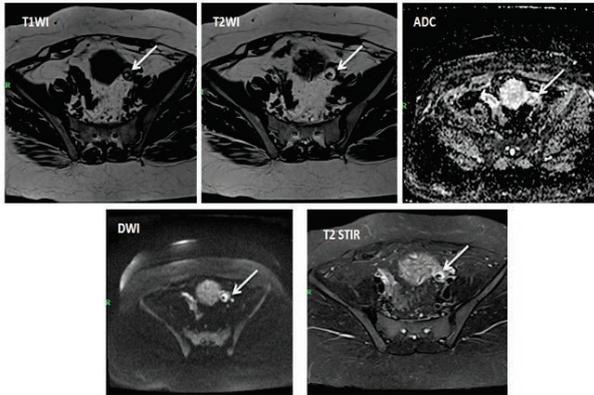
Fig. 1: A-39 Years Old Female with Complains of Abdominal Pain

Left ovary shows a well defined mixed signal intensity area without diffusion restriction with part of the area showing bright signal on T1 and T2 and signal suppression on STIR-Suggestive of fat-likely dermoid cyst (Fig 1).

Table 2: Distribution of Ovarian Lesions Based on MRI Characteristics

MRI Finding	Frequency	Percentage (%)
Lesion Type		
-Cystic	22	44
-Solid	12	24
-Complex (mixed)	16	32
Lesion Size (Cm)		
-<5	12	24
-5-10	30	60
->10	8	16
Presence Of Septation	14	28
Enhancement On Contrast MRI	26	52

This table outlines the MRI characteristics of ovarian lesions observed in the study. Cystic lesions were the most common, followed by complex lesions. The majority measured between 5-10cm, with <half showing enhancement on contrast MRI, a feature often linked to malignancy potential.
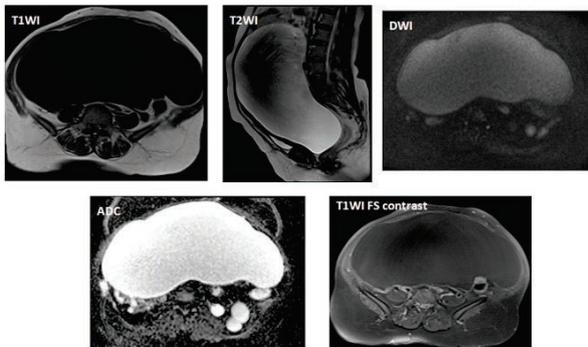

Fig. 2: A-62 Years Old Female with Abdominal Distention and Abdominal Pain

Serous cystadenoma of Ovary large well defined unilocular T1WI hypointense and T2WI hypointense abdominopelvic cystic mass lesion noted. No e/o/septation/solid components within the lesion. No e/o signal drop on gradient imaging. On post constrast study the lesion shows smooth wall enhancement. Uterus and right ovary: Not visualized (H/o) surgery (Fig.2).

Table 3: MRI Findings and Suspected Diagnosis

MRI Finding	Suspected Diagnosis	Frequency	Percentage (%)
Simple Cyst	Functional Cyst	12	24
Cyst with Septation	Endometrioma	3	6
	Serous cystadenoma	2	4
	Mucinous cystadenoma	1	2
Solid Mass with Enhancement	Malignant Lesion	13	26
Cyst with Fat Content	Dermoid Cyst	6	12
Bilateral Solid Lesions	Metastasis	3	6
Mixed Solid and Cystic Lesion	Borderline Tumor	4	8
Hemorrhagic Cyst	Hemorrhagic Cyst	5	10

This table categorizes MRI findings with suspected diagnoses. Malignant lesions were most frequently suspected in solid masses with enhancement, while functional cysts were the common benign findings. Other diagnoses included endometrioma, Serous cystadenoma, Mucinous cystadenoma and dermoid cysts.

Table 4: Correlation of MRI Findings with Histopathological Diagnosis (n=50)

MRI Diagnosis	Histopathology Diagnosis	Match (%)	Mismatch (%)
Benign	Benign	22 (44%)	2 (4%)
Malignant	Malignant	15 (30%)	5 (10%)
Borderline/Uncertain	Borderline	7 (14%)	1 (2%)
Total		44 (88%)	8 (12%)

This table shows the concordance between MRI and histopathology findings, with an 88% overall match rate. MRI diagnoses were more accurate in identifying benign cases, while malignant and borderline cases had a higher mismatch rate, highlighting MRI's diagnostic strengths and limitations.
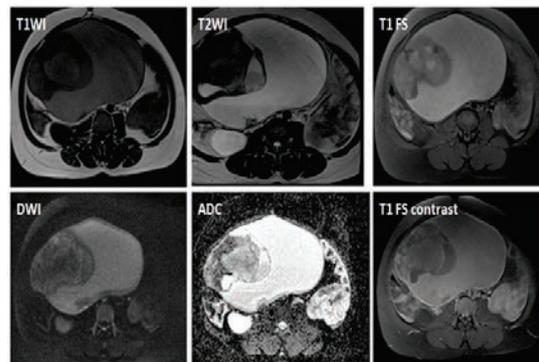

Fig. 3: A-43 Years Old Female with Complaints of Abdominal Pain and Distention

Mucinous cystadenocarcinoma large cystic lesion in the peritoneal cavity extending from the right adnexa region upto the epigastrium (D12 to S1). Cyst wall shows enhancement with smooth outline. The cyst contents showing high signal and intermediate signal on T1WI and TIFS images. Proteinaceous material. There is evidence of an eccentrically placed nodular lesion shows laboulated outline, heterogeneous low to high signal on T2WI/T1WI without any restricted diffusion and demonstrates few areas of blooming in GRE images. Calcification. Post contrast study shows heterogeneous enhancement of solid components with large non enhancing areas within it. Indicating necrosis (Fig. 3).

Table 5: Diagnostic Accuracy of MRI in Differentiating Benign and Malignant Ovarian Lesions

Parameter	Value (%)
Sensitivity	83
Specificity	91
Positive Predictive Value	87
Negative Predictive Value	86
Accuracy	88

This table summarizes the diagnostic performance of MRI in differentiating benign from malignant ovarian lesions. With high specificity and accuracy, MRI proved reliable in identifying lesion types, demonstrating strong utility in clinical settings for distinguishing between benign and malignant ovarian pathology.

This study on the role of MRI in evaluating ovarian lesions provides key insights into the imaging characteristics, diagnostic accuracy and potential of MRI as a diagnostic tool for ovarian pathology. By comparing our findings with previous research, we can better understand MRI's efficacy, consistency in diagnosis and alignment with histopathological outcomes in identifying benign and malignant lesions.

Demographic Characteristics: Our study revealed that the majority of participants were premenopausal, multiparous women between 31-40 years of age, which is consistent with prior studies showing higher prevalence of ovarian lesions in premenopausal women Kinkel[8]. The predominance of ovarian lesions in this age group could be attributed to higher physiological variability in ovarian cyst formation during reproductive years. Other studies have reported similar age distributions, suggesting that MRI's application across age and menopausal status is consistent with typical patient demographics for ovarian imaging Kaijser[9].

MRI Findings and Ovarian Lesion Types: The distribution of ovarian lesion types observed in our study aligns with those noted by Hricak[10], with cystic and complex lesions being the most common. Our study identified a predominance of lesions between 5-10cm, matching findings by Timmerman[11], who reported that benign lesions are more likely to be smaller and cystic, while malignant lesions tend to have more complex or solid components. Our observation that 52% of lesions showed enhancement on contrast MRI mirrors findings in studies by Outwater[12], which associated contrast enhancement with higher malignancy suspicion, particularly for lesions with solid components.

Correlation Between MRI and Histopathology: The correlation between MRI-based and histopathological diagnoses in our study demonstrated an 88% overall accuracy, with higher concordance rates in benign cases. This is consistent with the findings by Hricak[3], who observed MRI's strong concordance with histopathology in detecting benign lesions but noted slightly lower accuracy in distinguishing borderline or malignant lesions. Our study's mismatch rates for malignant and borderline cases underscore the complexity of diagnosing these lesions solely with MRI, as also discussed in studies by Kaijser[9], who recommended combining MRI with additional biomarkers to improve diagnostic specificity.

Diagnostic Accuracy of MRI: Our study found an MRI sensitivity of 83%, specificity of 91% and an overall accuracy of 88% in differentiating benign from malignant lesions. These values are comparable to Timmerman[11], who reported MRI sensitivity and specificity ranges from 85-90% for ovarian lesions. Similar studies, including one by Kinkel[8], also support MRI's high specificity and sensitivity, emphasizing MRI as a valuable tool in cases where malignancy is suspected. The high specificity observed in our study reaffirms MRI's efficacy in ruling out malignancy, thereby reducing unnecessary surgical interventions for benign cases.

Comparison with Other Diagnostic Modalities: Compared with other imaging modalities, MRI offers superior soft-tissue contrast and multi planar capability, making it particularly effective for characterizing complex ovarian lesions (Outwater[12]. Studies by Spencer[13] have highlighted MRI's advantages over ultrasound, particularly for complex or borderline lesions, where ultrasound may lack sufficient specificity. These findings are supported by our study, which showed MRI's high positive predictive value (PPV) for malignancy, particularly in lesions with contrast enhancement or complex characteristics.

Study Limitations and Future Directions: Our study is limited by its relatively small sample size, which may impact the generalizability of the findings. A larger cohort would provide a more comprehensive

assessment of MRI's diagnostic capabilities across various lesion types. Additionally, integrating advanced imaging techniques such as diffusion-weighted imaging (DWI) could improve MRI's sensitivity and accuracy, as recent studies have suggested that DWI may enhance malignancy detection in complex ovarian lesions Kaijser[9]. Future studies could also consider a combined diagnostic approach, utilizing MRI in conjunction with biomarkers like CA-125 to enhance diagnostic confidence.

CONCLUSION

The study emphasizes the importance of MRI in evaluating ovarian lesions, highlighting its high sensitivity and specificity in distinguishing benign from malignant lesions. MRI is effective in identifying lesion characteristics, such as size, cystic or solid nature, septation and enhancement patterns, aiding in accurate preliminary diagnoses. Its strong concordance with histopathological results, achieving an 88% overall match, validates its reliability as a non-invasive diagnostic tool. MRI is valuable for its accuracy, positive predictive value and detailed imaging, aiding in treatment planning and patient management. However, a small mismatch rate in malignant and borderline cases suggests that MRI findings should be supplemented with histopathological evaluation for confirmation and optimal treatment strategies. MRI's use could be expanded in clinical practice for early, accurate and safe evaluation of ovarian pathology, improving patient outcomes and guiding timely interventions.

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