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Diagnostic Accuracy of MRI in Differentiating Benign and Malignant Ovarian Masses

Dr. Bandi Babita Goud[1], Dr. Nitin D. Wadhwani[2], Dr. Prathamesh Vijay Kotawadekar[3]

[1]3rd year Post-Graduate Radiodiagnosis Resident, Department of Radiodiagnosis, Dr. D. Y. Patil Medical College Hospital and Research Institute, Kolhapur
Email: *babitasarika[at]gmail.com*

[2]HOD & Professor (M.D, DNB Radiodiagnosis, FRCR), Department of Radiodiagnosis, Dr. D. Y. Patil Medical College Hospital and Research Institute, Kolhapur
Email: *drnitinwadhwani[at]rediffmail.com*

[3]3rd Year Post-graduate Radiodiagnosis Resident, Department of Radiodiagnosis, Dr. D. Y. Patil Medical College Hospital and Research Institute, Kolhapur
Email: *pratham.pra10[at]gmail.com*

Abstract: ***Background: To evaluate MR imaging features in the detection and characterization of ovarian masses and to specify the accuracy of MRI in differentiating benign and malignant ovarian masses. Results: MRI findings showed high sensitivity (90.48%), specificity (100%) PPV (100%), NPV (88.24%), and accuracy (94.44%) in differentiating benign and malignant ovarian masses. Conclusions: We demonstrated that, when compared to ultrasound imaging, MRI has better results for diagnosing ovarian masses and their characteristics.***

Keywords: Magnetic resonance images, Ovary, ovarian masses

1. Introduction

Ovarian masses (OMS) encompass a diverse range of conditions within the female reproductive system, spanning from benign cysts to potentially malignant tumors. These masses carry considerable clinical significance due to their prevalence and the inherent risk of malignancy they pose. "According to the American Cancer Society, ovarian cancer (OC) ranks fifth in cancer-related deaths among women, with an estimated 21,410 new cases and 13,770 deaths projected in the United States for the year 2021.[1] According to the Globocan 2018 Fact Sheet, OC was projected to rank as the third most prevalent cancer in Indian women and eighth overall, comprising 3.44% (36170) of all cancer cases." Additionally, it stands as a significant contributor to cancer-related mortality among Indian women, accounting for 3.34% (24015) of all cancer fatalities in the country during the same year.[2] Data from Indian cancer registries highlight the significance of the ovary as a prominent cancer site, accounting for up to 8.7% of cancer instances in various areas of the country.[3]

OMS are a prevalent concern, impacting women across various age groups. The ovaries, crucial components of the female reproductive system, are susceptible to the development of varied types of masses. While many OMS are benign and do not immediately threaten health, the potential for malignancy underscores the importance of comprehensive evaluation and accurate diagnosis.[4]

2. Literature Survey

Medeiros LR et al (2011) conducted a quantitative systematic review to assess the diagnostic accuracy of MRI in ovarian tumors. "A total of fifteen primary studies were analyzed, encompassing 1267 OMS. In the context of borderline or malignant OC versus benign ovarian lesions, the pooled likelihood ratio for the occurrence of a positive MRI result was 6.6 (95% confidence interval, 4.7–9.2), and the post-test probability for a borderline or malignant diagnosis was 77% (95% confidence interval, 70–82)." The area under the curve for borderline or malignant OC versus "benign ovarian lesions was 0.9526. The study concluded that MRI appears to be a valuable preoperative test for forecasting the diagnosis of pelvic masses. [5]"

Zhang P et al (2012) carried out a study to assess the effectiveness of ADC in describing "complex solid and cystic AM". A total of 191 patients underwent DWMRI for 202 OMS. "The mean ADC value of the solid components was measured and evaluated for each ovarian mass. Among the patients, 85 were premenopausal, and 106 were postmenopausal. Out of the 202 OMS, 74 were identified as benign, and 128 as malignant. The study revealed a significant difference in mean ADC values between benign and malignant OMS ($p < 0.05$). However, no significant differences in ADC values were observed between fibrothecomas, Brenner tumors, and malignant OMS." "Receiver Operating Characteristic (ROC)" analysis suggested that a "cutoff ADC value of 1.20 × 10-3 mm2/s might be optimal for distinguishing between benign and malignant tumors. Moreover, a high signal intensity within the solid component on T2-weighted images was less frequent in benign AM than in malignant ones. The study concludes that the combination of DW imaging with ADC value measurements and T2-weighted signal characteristics of solid components proves valuable in differentiating between benign and malignant OMS.[6]"

3. Problem Definition

The differential diagnosis of ovarian masses is always challenging for the radiologists. MRI plays a key role in the work up of ovarian lesions, identifying features that distinguish benign and malignant lesions. It can also be useful in detection, characterization, classification and staging of ovarian tumors which can influence patient management. Most importantly MRI can be helpful to avoid Preoperative biopsy, as this invasive procedure raises the risk of spreading cancer cells and potentially leads to iatrogenic upstaging worsening the prognosis.

This study, therefore, presents a novel evaluation to determine accuracy of MRI in differentiation of Benign and Malignant ovarian masses.

4. Materials and Methods

a) **Type of Study:** Prospective, observational, comparative study
b) **Study setting:** Patients referred for an MRI Pelvis to the Department of Radiodiagnosis, Dr. D.Y. Patil Medical College Hospital and Research Institute, Kadamwadi, Kolhapur
c) **Sample size:** Minimum 36 subjects, fulfilling the inclusion and exclusion criteria will be included in the study.

Calculation:
The sample size was calculated by using the following formula:

$$n = \frac{(Z_\alpha)^2\, p_1(1 - p_1)}{(d)^2}$$

Where Z_a is the critical value of the normal distribution at α (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96, p1 is the expected prevalence and d is Margin of error. Taking, = 3.44 % = 0.0344 and d = 6% = 0.06, the minimum sample size is calculated as follows

$$n = \frac{(1.96)^2 \times 0.0344 \times (1 - 0.0344)}{(0.06)^2}$$

n= 36
Minimum sample size is 36

d) Study design:
For 18 months, study was carried out, The source of data for this study are patients referred to the Department of Radiodiagnosis, Dr. D. Y. Patil Medical College Hospital and Research Institute, Kadamwadi, Kolhapur.

Inclusion Criteria:
- All patients with clinically suspected adnexal/pelvic masses.
- Patients referred to the department of radio-diagnosis with Imaging requisition on advice of a referring doctor.
- Patients of all age groups.

Exclusion Criteria:
- Patients who have underwent treatment for ovarian masses.
- Patients with metallic implants, cardiac pacemakers, cochlear implants.
- Patients with non-neoplastic ovarian condition such as PCOS, tubo-ovarian abscess, follicular cyst, etc.
- Patients with metastasis to ovary from primary of non-ovarian origin.
- Patients with claustrophobia.

Methodology
Patients with suspicion of adnexal masses / ovarian lesions, screened on USG will be selected. In this study, 36 patients fulfilling the inclusion and exclusion criteria are included. All the patients selected are subjected to MRI 3 Tesla Philips Achieva 3.0T Machine and images are obtained. The MRI examinations of the lower abdomen will be performed in the supine position using a multichannel phase array coil. The images obtained are analysed. Results are correlated with their respective Histopathology/ cytopathology reports after biopsy / FNAC/ surgical intervention.

Statistical Analysis
The data was entered into MS Excel and then imported into SPSS for analysis. The data were analysed using SPSS V 1.2.5001 software.

5. Results and Discussion

A) Age
The mean age of the study subjects was 49.39±9.38 years

Table 1: Distribution of subjects according to age

Age (years)	Benign	Malignant	Frequency (n)	Percentage (%)
31-40	5	1	6	16.67
41-50	6	8	14	38.89
51-60	5	5	10	27.78
61-65	1	5	6	16.67
Total	17	19	36	100

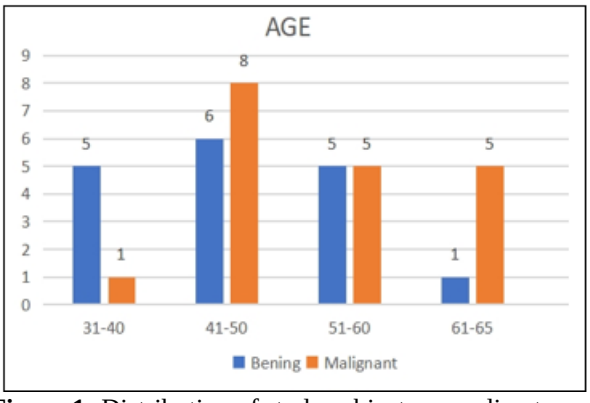


Figure 1: Distribution of study subjects according to age

B) Size of ovarian masses

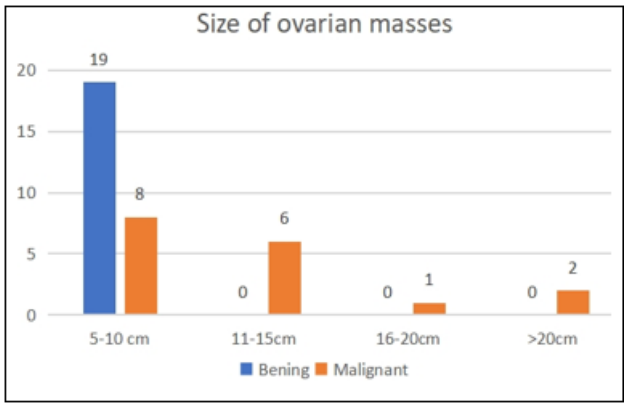


Figure 2: Distribution of subjects according to size of ovarian masses

C) MRI features and its findings

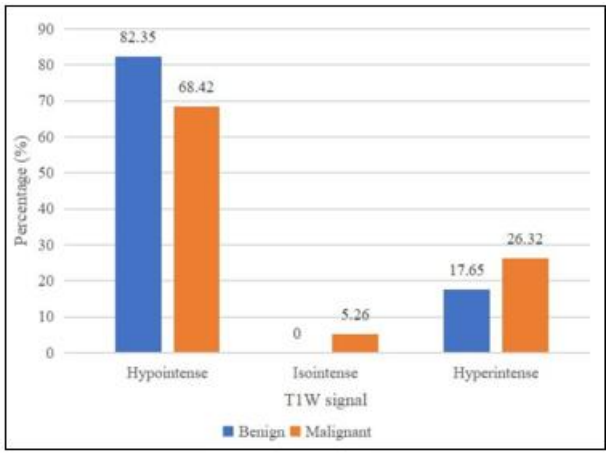


Figure 3: Distribution of subjects according to T1W features on MRI

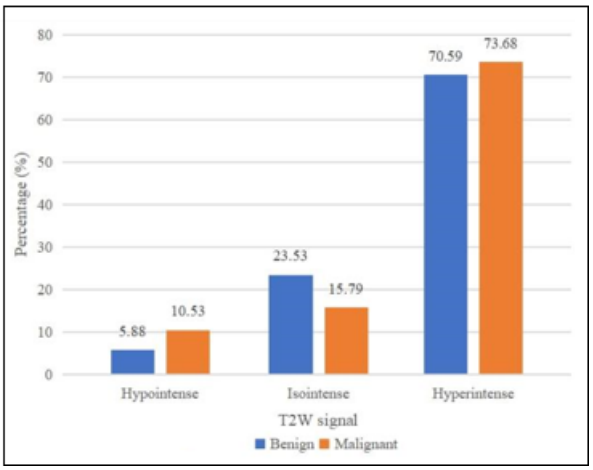


Figure 4: Distribution of subjects according to T2W on MRI

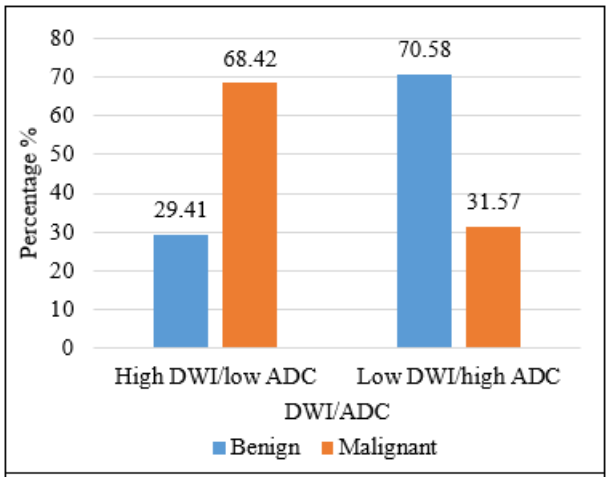


Figure 5: Distribution of subjects according to DWI/ADC on MRI

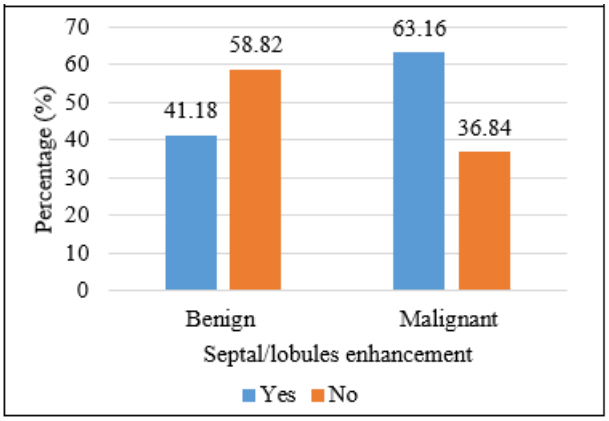


Figure 6: Distribution of subjects according to Septal/Lobule enhancement

D) Lesion characteristics according to MRI

Among n=19 patients with malignant lesions, MRI showed irregular margins and lymphadenopathy in n=16 (84.21%) patients respectively followed by n=15 (78.95%) patients were found with thick septa. Whereas, thick wall, ascites, and solid cyst were found in n=12 (63.16%) patients respectively. Papillary projections and solid portion was observed in n=10 (52.63) and n=11 patients (57.89%) respectively. In patients benign lesions (n=17), the most common lesion character was solid cyst seen in n=14 (82.35%) subjects followed by lymphadenopathy (n=8, 47.06%), thick wall (n=7, 41.18%) and thick septa (n=6, 35.29%)

Table 3: Distribution of subjects according to lesion characteristics

Lesion characteristics	Malignant n, (%)	Benign n, (%)
Irregular margins	16 (84.21)	3 (17.65)
Thick wall	12 (63.16)	7 (41.18)
Thick septa	15 (78.95)	6 (35.29)
Papillary projections	10 (52.63)	2 (11.76)
Solid portion	11 (57.89)	4 (23.53)
Ascites	12 (63.16)	1 (5.88)
Lymphadenopathy	16 (84.21)	8 (47.06)
Solid cystic	12 (63.16)	14 (82.35)

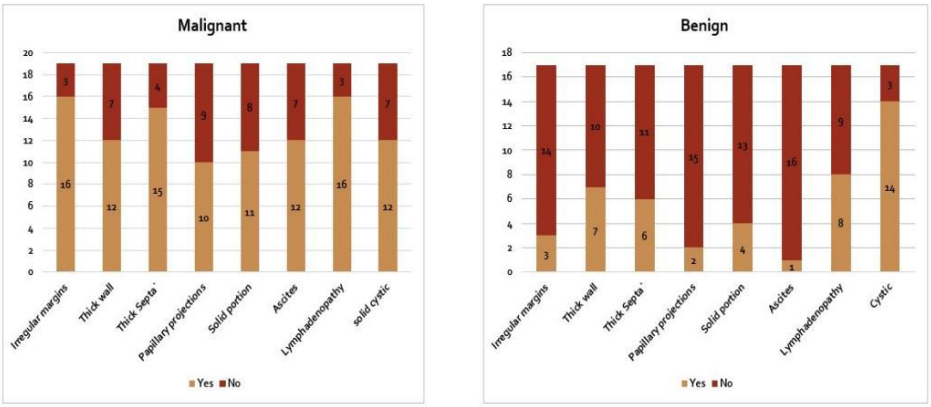


Figure 7: Distribution of subjects according to lesion characteristics

Table 3: Distribution of subjects according to MRI findings and histopathological findings

MRI findings	Histopathological findings		Total n, (%)
	Benign n, (%)	Malignant n, (%)	
Benign	15 (88.24)	2 (11.76)	17 (100)
Malignant	0 (0)	19 (100)	19 (100)
Total	15 (41.66)	21 (58.34)	36 (100)

6. Discussion

The current study was conducted to assess the diagnostic accuracy of MRI in distinguishing benign and malignant OMS. A total of 36 subjects with clinically suspected "adnexal/pelvic masses" were involved in the study. The mean age of the study populations was 49.39±9.38 years, with the majority belonged to the 41-50 years age group. This finding underscores the common occurrence of OMS in females over the age of 40.

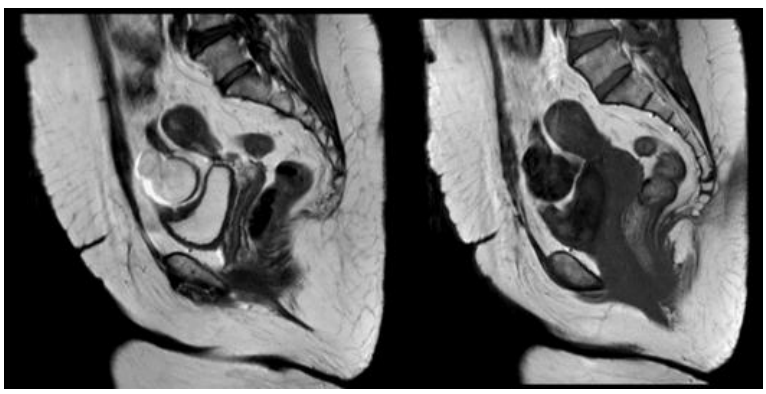
In this study, the maximum number of women (55.56%, n=20) had unilateral OMS whereas, it was bilateral in 44.44% (n=16) of subjects, as well as the size distribution of the lesions reflecting reflects the heterogeneity of OMS encountered in clinical practice. In the investigation conducted by Ladke P et al, it was observed that over 70% of AM manifested unilaterally.[7]

Bilateral cancers often demonstrate increased invasiveness into surrounding structures in comparison to unilateral masses. Additionally, the limited invasiveness observed in unilateral lesions typically correlates with lower rates of "residual tumors or missed lesions". The presence of bilateral masses often signifies "synchronous tumorigenesis and metastasis" from one side to the other. The higher prevalence of unilateral masses observed in our study suggests a lower degree of invasiveness associated with these lesions. [8]

Regarding MRI findings, we observed certain patterns that distinguish benign from malignant lesions. Hypointense T1-weighted signal was more frequently observed in malignant lesions, while hyperintense T2-weighted signal was more common in benign lesions. These results are reliable with earlier studies that have emphasized the utility of T1 and T2 signal characteristics in characterizing OMS. Similar findings are reported by El-Wekil AM et al. [9]

Moreover, DWI and ADC mapping are emerging as valuable tools in the assessment of OMS. In this study, high DWI signal with low ADC values was more prevalent in malignant lesions, whereas benign lesions exhibited a wider range of DWI and ADC characteristics which is comparable with the study of El-Wekil AM. et al. [10] These results underscore the potential of DWI and ADC mapping as adjuncts to conventional MRI sequences in the differentiation of OMS.

Furthermore, the existence of septal/lobule enhancement was more commonly observed in malignant lesions. This observation is consistent with the histopathological features of malignant ovarian tumors, which often exhibit complex internal architecture characterized by septations and solid components.



A B

Figure: Serous Cystadenoma
(A)T2W MRI (B)T1W MRI Showing cystic lesion with internal septation which is bright on T2 and dark on T1

7. Summary

The research aimed to evaluate the diagnostic accuracy of MRI in distinguishing between "benign and malignant OMS". The study involved a cohort of women with varying ages, with the majority falling between 41 to 50 years. Most subjects presented with unilateral OMS, and the size of lesions predominantly ranged from 5cm to 10cm.

MRI findings indicated that 52.78% of the subjects had malignant lesions, while 47.22% had benign ones. Analysis of MRI signals revealed specific patterns associated with each type of lesion. For instance, hypointense T1W signals were more common in malignant lesions, while hyperintense T2W signals were frequently observed in benign lesions. Additionally, DWI and ADC values differed between benign and malignant masses, with specific patterns indicating each category.

Enhancement patterns also varied, with septal/lobular enhancement more prevalent in malignant lesions. Comparing MRI findings with histopathological results, MRI demonstrated "high sensitivity (90.48%) and specificity (100%) in distinguishing between benign and malignant OMS. The positive predictive value (PPV) and negative predictive value (NPV)" were both 100%, indicating the reliability of MRI in accurately identifying malignant masses and ruling out benign one

8. Conclusion

The study aimed to assess the diagnostic accuracy of MRI in differentiating benign and malignant OMS. The study underscores the significant role of MRI in the accurate diagnosis and distinction of OMS.MRI findings showed high sensitivity (90.48%), specificity (100%) PPV (100%), NPV (88.24%), and accuracy (94.44%) in distinguishing benign and malignant OMS. Further studies warranted to confirm present study finding

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Author Profile

Dr. Bandi Babita Goud, 3rd Year Post-graduate Radiodiagnosis resident
Email: babitasarika[at]gmail.com

Dr. Nitin D. Wadhwani, HOD & Professor (M.D, DNB Radiodiagnosis, FRCR)
Email: drnitinwadhwani[at]rediffmail.com

Dr. Prathamesh Vijay Kotawadekar, 3rd year Post-graduate Radiodiagnosis resident
Email: pratham.pra10[at]gmail.com