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Original Research Paper

Oncology

THE ROLE OF ULTRASOUND AND MRI IN THE DIAGNOSIS OF OVARIAN TUMOURS

Dr. Nidhi Nair*	Department of Medical Oncology, Tata Memorial Hospital, Parel, Mumbai. *Corresponding Author
Dr. Aruna Muthumanickam	Department of Internal Medicine, Bronxcare Health System, Icahn School of Medicine at Mount Sinai, New York.
Dr. Soorya K	Department of Radiodiagnosis, MGM Medical College, Indore.

ABSTRACT ***Background:*** Ovarian cancer is the fifth leading cause of cancer related death in the USA, and has the highest mortality rate due to late diagnosis. The most common modalities used in diagnoses are B-Mode USG, Conventional MRI and DW-MRI. This study aims to statistically analyze and compare the sensitivity, specificity and measurement of agreement for these modalities. ***Method:*** From March 2019 to September 2020, 103 patients with ovarian masses underwent radiodiagnostic testing with USG and MRI, and subsequently 85 patients underwent surgery and the gold standard histopathological examination. The radiologic diagnosis was correlated with the histopathologic diagnosis for these patients and the sensitivities, specificities and area under the ROC curve were calculated. ***Results:*** The area under ROC curve increased in the following order: B- Mode USG < B-Mode USG & Doppler combined < conventional MRI < DW-MRI. The measurement of agreement Kappa increased in the following order: B- Mode USG < B-Mode USG & Doppler combined < conventional MRI < DW-MRI. The study showed that addition of Doppler to B-Mode USG reduced its sensitivity and NPV. Both USG and conventional MRI were found to have comparable sensitivities. ***Conclusion:*** While DW-MRI is superior to other modalities in its high specificity in diagnosing ovarian tumors, USG has equal sensitivity and can be used for initial presumptive diagnosis in patients with suspected ovarian malignancies.

KEYWORDS : Ultrasound, MRI, Ovarian tumors, Gynecologic radiology

OBJECTIVES:

1. To assess the diagnostic accuracy of B-Mode USG for characterization of ovarian masses.
2. To assess the diagnostic accuracy of Diffusion Weighted MRI for characterization of ovarian masses.
3. To correlate the accuracy of the findings of MRI with USG.
4. To independently assess the sensitivity and specificity of USG and MRI in diagnosing ovarian masses by comparing findings to histopathology.

INTRODUCTION:

Ovarian pathologies are currently among the widest and most complex problems in modern gynaecology, mainly constituted by ovarian tumours. The incidence of ovarian carcinoma is estimated to increase to 371,000 a year by 2035 (55%), and the death rate by 67% to 254,000.[1] This increased lethality of ovarian cancer can be attributed to several factors, an important one being the delay in diagnosis due to the insidious asymptomatic growth of tumours, late onset of symptoms and lack of adequate screening. According to the SEER database, maintained by the National Cancer Institute, USA, ovarian cancer survival rate exceeds 90% if diagnosed while confined to ovary (stage I). This number drops to 70% in stage II, 39% in stage III and 17% in stage IV.[2]

This makes the management of ovarian tumours challenging, and highlights the need to improve diagnostic modalities for the early detection and evaluation of ovarian masses.Of all the various imaging modalities available, ultrasonography continues to be the mainstay, owing to its wide availability, patient acceptance and low cost. But, it has shortcomings such as a restricted field of view, pelvic organs being obscured by bowel gas and its dependence on the operator's skill.

MRI, on the other hand, can delineate lesions much better because of its good soft-tissue contrast and direct multiplanar capabilities. However, it is employed less often owing to its high cost and reduced availability.

Understanding these imaging modalities available to diagnosing ovarian masses will go a long way in optimizing their use to improve disease outcome and long term prognosis. We would like to present to you a research study conducted to compare and contrast the efficacy of USG vs MRI based characterization of ovarian masses.

MATERIALS AND METHODS:

This study was conducted as a cross sectional study, from March 2019 to September 2020, in an urban teaching hospital. A total of 103 patients were involved in the study. Prior to initiating the study, IRB approval was obtained. The radiodiagnostic modalities used included 3T MRI and Ultrasonography with curvilinear transabdominal and transvaginal probes. The IOTA guidelines were used while assessing ovarian tumors with USG. The age distribution of patients involved were as shown:

TABLE 1: AGE DISTRIBUTION

Age [in Years]	Number of Cases	Percentage [%]
18 to 27	23	22.3
28 to 37	21	20.4
38 to 47	20	19.4
48 to 57	20	19.4
58 to 67	18	17.5
>67 years	1	1
Total	103	100

The inclusion criteria for study participants were as follows:

1. Individuals above the age of 18 years, with suspicion of high risk ovarian lesions, without a history of prior MRI or histopathological study.

The exclusion criteria for study participants were as follows:

1. Individuals < 18 years.
2. Those with general contraindications to MRI.
3. Patients who had previously undergone oophorectomy.
4. Patients who were pregnant.
5. Patients diagnosed with suspected infectious etiology.
6. Patients with prior established diagnosis of ovarian pathology.

Following selection of patients, imaging procedures and nature of the study was explained to all participants and written-informed consent was obtained. A detailed history and physical examination were recorded. Transabdominal and transvaginal ultrasound examinations and subsequently MRI evaluation was performed. The lesions were evaluated in terms of morphology, including cystic vs solid lesions, septate vs nonseptate, echogenicity, presence of solid portions, laterality, vascularity, diffusion restrictions and presence of ascites. These patients were then followed up until histopathological results were available. The imaging findings were then correlated with the histopathological analyses.

Statistical analysis was performed using SPSS. Appropriate statistical measures including calculation of mean, median and measurement of agreement (Cohen's Kappa) were done.

Pearson's correlation coefficient was also calculated. P value of <0.05 was selected as statistically significant. The ROC curve was plotted and the area under the curve was calculated. The optimal cut-off point was determined by Youden's J statistic.

RESULTS:

Of the 103 patients evaluated with both US and MRI, 85 patients underwent surgical treatment and histopathological diagnosis. The initial assessment of cystic vs solid lesions using USG showed that 64.1% patients (n = 66) had cystic lesions, 2.9% patients (n = 3) had solid lesions, and 33% patients (n=34) had mixed lesions. Among those who had cystic lesions, further assessment was done for locularity, the presence of septae, solid components, papillary projections and calcifications. Similarly, in a study conducted by Guerra et al[3] in 2008, 62% of the lesions were cystic, concordant with our results.

Among the 66 cystic lesions, 48% (n=32) were unilocular and 52% (n=34) were multilocular, septations were thin in 45% (n=30) and thick in 3.8% (n= 4). Papillary projections were seen in 34% of combined cystic and mixed cases (n=35). Papillary projections favour a malignant nature of lesions. In a study conducted by Lamiaa Khalaf et al in 2018[4], 32.7% of their cases had papillary projections, similar to the findings in our study.

Out of the 103 study participants, USG evaluation showed that 21.3% (n = 22) had ascites, 6.8% (n = 7) had omental deposits, 4.9% (n = 5) had lymphadenopathy, 2.9% (n = 3) had suspected metastatic deposits to the liver, and 4.8% (n = 5) had pleural effusion. Similarly, Shane-Gunther et al[5] in 2002 observed ascites in 19.3% of their cases, while a study conducted by Guerra et al[3] in 2008, ascites was present in 32%, peritoneal nodules in 8.9% and pelvic lymphadenopathy in 4%.

Overall assessment of all participants with B-mode USG alone revealed radiologically benign lesions in 66% (n = 68, of 103 patients), and 34% (n = 35, of 103 patients) had malignant lesions. When results of B-mode and USG were combined, analysis showed that 72.8% (n = 75) lesions were radiologically benign, while 27.2% (n = 28) were malignant on imaging.

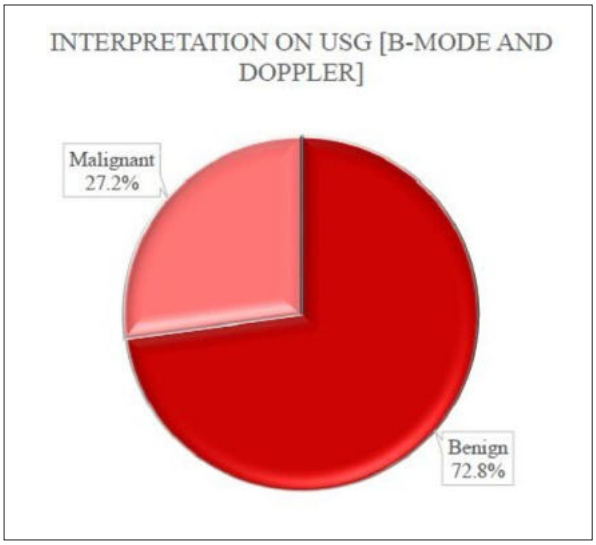

FIGURE 1: USG INTERPRETATION

On T2 weighted MRI images, 35% (n=36) lesions had thin septations and 24% (n=25) had thick septations. Papillary projections were present in 34% (n=35) of the cases.

Out of 103 cases evaluated with MRI in this study, 47 were found to have ancillary pathological findings. Assessment of these findings showed that 21.3% (n= 22) had ascites, 9.7% (n=10) had omental deposits, 6.7% (n=7) had lymphadenopathy, 2.9% (n=3) had metastatic lesions in the liver and 4.8% (n=5) had pleural effusion. According to the study done by Zhang P., et al[6] in 2012, 9.1% had peritoneal deposits, demonstrating concordance with our results.

Overall evaluation of the patients on conventional MRI alone revealed radiologically benign lesions in 72% (n=74, of 103) and malignant lesions in 28% (n=29, of 103) of the masses studied. On interpretation of the ovarian lesions on Diffusion Weighted MRI, 69% were benign (n=71, of 103) and 31% (n=32, of 103) malignant.

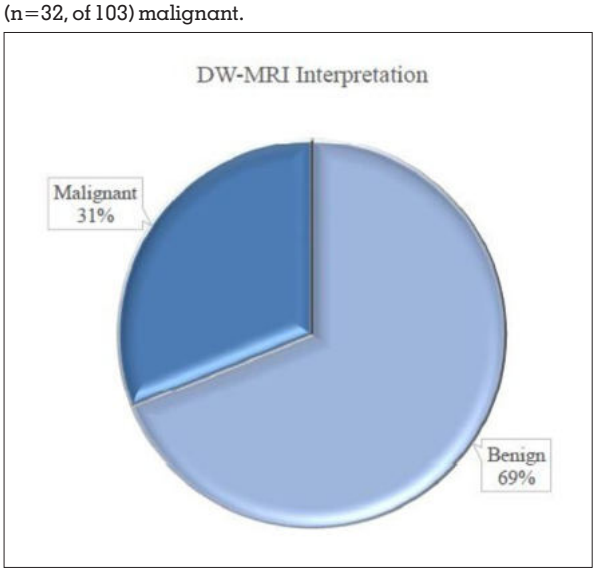

FIGURE 2: DW-MRI INTERPRETATION

Of 103 cases studied, 85 underwent surgery and

histopathological examination was done. 8 cases resolved on follow-up. 10 cases were lost to follow-up. Out of 85 patients, 61% (n=52) had benign ovarian lesions and 39% (n=33) had malignant ovarian lesions.

TABLE 2: HISTOPATHOLOGICAL ANALYSIS

Histopathological Report	Number of Cases	Percentage [%]
Benign	52	61
Malignant	33	39
TOTAL	85	100%

USG and MRI interpretation of these 85 lesions were compared. On evaluation with USG, 67% (n=57) cases were characterised as benign and 33% (n=28) as malignant. On evaluation with MRI, 62% (n=53) cases were characterised as benign and 38% (n=32) as malignant.

TABLE 3: COMPARISON OF RADIOLOGICAL FINDINGS WITH HPE

	Benign		Malignant	
	Number of Cases	Percentage [%]	Number of Cases	Percentage [%]
USG	57	67	28	33
MRI	53	62	32	38
HPE	52	61	33	39

On comparison of the radiological findings with the corresponding HPE reports, the sensitivity, specificity, positive and negative predictive values as well as accuracy for the imaging procedures was calculated as follows:

TABLE 4: CALCULATION OF ACCURACY

	USG [B-mode]	USG [B-mode + Doppler]	Conventional MRI	DW-MRI
Sensitivity [%]	81.82	75.76	81.82	93.94
Specificity [%]	84.62	94.23	96.15	98.08
PPV [%]	77.14	89.29	93.10	96.88
NPV [%]	88.00	85.96	89.29	96.23
Accuracy [%]	83.53	87.06	90.59	96.47

The area under the ROC curve increases in the following order: USG [B-mode] < USG [B-mode + Doppler] < Conventional MRI < DW-MRI. It is evident that all of them showed outstanding discrimination and the maximum was for DW-MRI.

On calculation of Cohen's kappa and % of agreement (with HPE findings) it was found that the agreement with the histopathological diagnosis progressively increases in the following order: USG [B-mode] < USG [B-mode + Doppler] < Conventional MRI < DW-MRI.

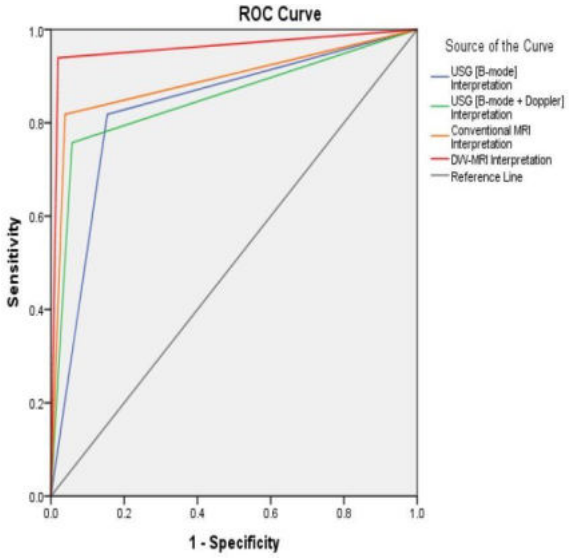

FIGURE 3: ROC CURVE

DISCUSSION AND CONCLUSION:

Till date, ultrasonography has been the preferred imaging modality for the evaluation of pelvic masses due to its universal availability, cost-effectiveness, high sensitivity rate and absence of exposure to ionizing radiation.[4]

MRI on the other hand is another non-invasive imaging modality that produces better soft-tissue demarcation. Diffusion-weighted MRI (DW-MRI) is a step forward in MRI techniques, and adds functional information to the anatomical visualization. It increases the contrast between lesions and adjacent tissues, providing quantitative information about tissue cellularity.

From the comparison table of sensitivity, specificity, PPV, NPV, it can be concluded that evaluation with USG B-mode alone has significant sensitivity and NPV, but adding Doppler evaluation, improved its specificity, PPV and accuracy, while decreasing sensitivity and NPV. Hence, by the addition of Doppler evaluation, the imaging modality becomes less efficient in ruling out ovarian malignancy. However, when Doppler findings are suggestive of malignant ovarian lesions, chances are more likely for the lesion to be truly malignant.

Our study also demonstrates that while the diagnostic accuracy of conventional MRI was better than USG, both imaging modalities had equal sensitivity. This finding emphasizes the role of USG as a screening tool, given its high sensitivity, increased availability, and relative ease of administration and portability. On the other hand, our study also shows that DW-MRI has the highest diagnostic accuracy and highest specificity, and is superior to other tests for evaluating ancillary lesions, reinforcing its role in aiding diagnostic confirmation, and staging of lesions.

Keeping with the principles of Precision Medicine in cancer diagnostics and therapeutics, it is important to compare and contrast different imaging modalities[8], to be able to select the most appropriate tools for every patient and patient population. There is not enough literature in the scientific community to establish an optimal guidelines for the screening and detection of ovarian masses, and we hope that this paper will help further current knowledge.

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