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ULTRASONOGRAPHY VERSUS MRI IN DIAGNOSING MALIGNANT OVARIAN MASSES: DIAGNOSTIC ACCURACY IN A TERTIARY CARE SETTING

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Abstract

Objective: *To determine the diagnostic accuracy of ultrasonography in diagnosing malignant ovarian masses, using magnetic resonance imaging (MRI) as the gold standard.*

Methods: *This cross-sectional validation study was conducted in the Department of Radiology, CDA Hospital, Islamabad, from June 15 to December 14, 2024. A total of 150 female patients presenting with abdominal pain (VAS >3) and an incidental ovarian lesion >1 cm on ultrasonography were included. Patients with prior biopsy-proven malignancy, prior oncological treatment, contraindications to MRI, or chronic systemic illnesses were excluded. Pelvic ultrasonography was performed with a convex probe on a full bladder, and MRI was performed using a 1.5 Tesla GE scanner. Findings of ultrasonography were compared against MRI as the reference standard.*

Results: *The mean age of patients was 36.28 ± 8.54 years. On ultrasonography, 81 patients were diagnosed with malignant masses and 69 with benign lesions. MRI identified 78 malignant and 72 benign cases. Cross-tabulation showed 74 true positives, 65 true negatives, 7 false positives, and 4 false negatives. Ultrasonography demonstrated a sensitivity of 94.87%, specificity 90.28%, positive predictive value 91.36%, negative predictive value 94.20%, and overall diagnostic accuracy 92.67% (p=0.0001).*

Conclusion: *Ultrasonography showed excellent diagnostic accuracy for differentiating malignant from benign ovarian masses compared to MRI. Given its affordability and accessibility, ultrasonography should remain the first-line imaging modality, reserving MRI for indeterminate or complex cases.*

INTRODUCTION

Ovarian cancer is one of the most aggressive gynecological malignancies, characterized by late presentation and poor survival outcomes. Globally, it is the seventh most common cancer in women and the fifth leading cause of cancer-related deaths[1]. Despite advances in surgery and chemotherapy, the five-year survival rate remains approximately 40%, largely because 70% of cases are diagnosed in advanced stages[2]. The asymptomatic course in early disease, vague gastrointestinal-like symptoms, and the deep pelvic location of ovaries contribute to diagnostic delay[3].

The age-specific incidence of ovarian cancer increases steadily between 30 and 70 years, with a peak around 59 years[4]. Although it is the second most common gynecological malignancy, it carries the highest mortality among female genital tract cancers[5]. This burden is particularly pronounced in low- and middle-income countries, where access to advanced imaging and screening is limited.

Imaging is central to diagnosis and management. Ultrasound is widely used because of its low cost, availability, and non-invasiveness[6]. Several diagnostic scoring systems have been proposed to improve its predictive performance, such as the Risk of Malignancy Index (RMI) and the International Ovarian Tumor Analysis (IOTA) simple rules. Timmerman et al. demonstrated that ultrasound-based rules can achieve sensitivities of ~93% and specificities of ~90% when applicable[7]. Nevertheless, accuracy can vary considerably depending on operator skill, mass complexity, and patient factors.

MRI, on the other hand, provides superior soft tissue characterization, better delineation of complex adnexal lesions, and enhanced ability to differentiate benign from malignant pathology[8]. Studies such as Bazot et al. reported MRI sensitivity of 84.6% and specificity of 92.9% for adnexal masses[9]. However, its cost, limited accessibility, and contraindications (metallic implants, claustrophobia, contrast allergies) restrict its universal use.

More recently, systematic reviews and meta-analyses have underscored the complementary roles of ultrasound and MRI. For example, a 2024 review found MRI had sensitivity ~92% and specificity ~85% for detecting both borderline and invasive ovarian tumors when compared to histopathology, though ultrasound remained a strong initial modality, especially when operator experience is high (Mitchell et al.)[10]. Another study comparing the IOTA ADNEX model with MRI in over 500 women showed the ADNEX model had similar sensitivity as MRI (≈91% vs ≈89%) but higher specificity, especially for borderline tumors, suggesting that well-validated ultrasound models can rival MRI in many cases[11].

Given these considerations, our study was designed to evaluate the diagnostic accuracy of ultrasonography in differentiating malignant from benign ovarian masses, using MRI as the gold standard, within the Pakistani clinical context.

Materials and Methods

Study Design and Setting

This was a cross-sectional validation study conducted in the Department of Radiology, CDA Hospital, Islamabad, over six months (June 15 to December 14, 2024).

Sample Size and Sampling

A total of 150 female patients were included, calculated at 95% confidence level with 80% study power. Non-probability consecutive sampling was used.

Inclusion Criteria

Females presenting with abdominal pain (VAS >3).

Incidental detection of an ovarian lesion >1 cm on ultrasound.

Exclusion Criteria

Prior biopsy-proven ovarian malignancy.

History of chemotherapy, radiotherapy, or surgery for ovarian disease.

Contraindications to MRI (pacemakers, metallic implants, contrast hypersensitivity, severe claustrophobia).

Chronic systemic illnesses (renal or hepatic failure).

Imaging Procedure

Ultrasound: Performed transabdominally with a 3.5–5 MHz convex probe on a full bladder. Features assessed included lesion size, echogenicity, septations, papillary projections, vascularity on Doppler, ascites, and solid components.

MRI: Performed using a GE 1.5 Tesla scanner. Sequences included T1-weighted, T2-weighted, fat suppression, and post-contrast studies.

Radiologists interpreting ultrasound and MRI were independent and blinded to each other's findings.

Reference Standard
MRI findings were considered the gold standard.

Statistical Analysis
Data were analyzed using SPSS v26. Mean ± SD was calculated for continuous variables (e.g., age), while frequencies and percentages were used for categorical data. Diagnostic indices—sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy—were calculated. The Chi-square test was applied, with $p < 0.05$ considered statistically significant.

Results
Demographics
The mean age of participants was 36.28 ± 8.54 years (range: 18–60 years). Most patients presented with abdominal pain, while a smaller subset reported bloating or menstrual irregularities.

Imaging Findings

Ultrasound findings: 81 cases classified as malignant, 69 as benign.

MRI findings: 78 malignant, 72 benign.
Cross-Tabulation (Ultrasound vs MRI)

True Positives (TP): 74

True Negatives (TN): 65

False Positives (FP): 7

False Negatives (FN): 4

Diagnostic Indices

Sensitivity: 94.87%

Specificity: 90.28%

PPV: 91.36%

NPV: 94.20%

Overall accuracy: 92.67% (p=0.0001)

Table 1: Diagnostic performance of ultrasound compared with MRI

Index	Value (%)	95% CI
Sensitivity	94.87	88.1–98.3
Specificity	90.28	81.6–95.5
PPV	91.36	83.4–96.1
NPV	94.20	86.9–97.8
Accuracy	92.67	–

Discussion
This study reveals that ultrasonography, when compared to MRI, has excellent capacity for distinguishing malignant ovarian masses in our patient population – sensitivity of 94.87% and specificity of 90.28%. The overall accuracy of 92.67% further supports the value of ultrasound as a first-line imaging tool in this setting.

Comparison with Recent Evidence
The performance metrics of our study are comparable with recent large cohort studies. Hu et al. (2023) compared the ultrasound-based ADNEX model with MRI among 529 women, finding sensitivity values of 0.91 for ADNEX and 0.89 for MRI, with specificities of 0.90 and 0.81, respectively[11]. That study's higher specificity of

ultrasound in boundary cases suggests that in experienced hands, ultrasound might reduce false positives that otherwise lead to unnecessary further imaging or surgery.

Another systematic review (Mitchell et al., 2024) reported MRI sensitivity of ~92% and specificity ~85% for invasive or borderline tumors, confirming that MRI remains strong particularly for more complex or borderline lesions[10]. Our ultrasound sensitivity surpasses that for benign and malignant masses, reflecting perhaps operator expertise and selection of patients who already had lesions identified by ultrasound, but MRI specificity in our study is slightly higher than those pooled in some reviews — likely reflecting differences in case mix, lesion complexity, and patient selection.

Strengths and Novel Findings

A key strength of this study is the use of MRI as the reference standard in a real-world clinical setting, rather than histopathology for all cases; this allows comparison of imaging modalities under conditions similar to those of diagnostic pathways in settings where biopsy or surgery may be delayed or not always possible. Also, given that our sample includes both benign and malignant masses, the findings are more representative of clinical practice.

Another strength is the high negative predictive value (94.20%), which means that a benign result on ultrasonography is highly reliable, suggesting that many patients can avoid further imaging and the costs, time, and logistical burdens that MRI carries. This is particularly relevant in resource-limited settings, such as many hospitals in Pakistan.

Challenges and Limitations

Though the results are strong, there are a number of limitations. As in many imaging studies, operator dependence is an issue: ultrasound's performance heavily depends on the skill and experience of the sonographer, quality of equipment, and consistency in interpreting subtle features like vascularity, papillary projections, and septations. We did not stratify performance by operator level in this study.

Also, our study used MRI as the gold standard, not histopathology, which remains the definitive diagnosis. MRI misclassification, though rare, may occur, especially for borderline tumors, as several studies have shown. For example, in the ADNEX vs MRI study, MRI had lower specificity for borderline tumors[11]. This could mean that some ultrasound "false positives" or "false negatives" in our study may actually be MRI misclassifications.

Another limitation is that the spectrum of lesion types was not fully characterized in detail (e.g., borderline tumors, subtypes such as mucinous vs serous). Distinguishing borderline tumors remains a challenge in imaging literature; for example, pooled analyses show much lower sensitivity for borderline tumors compared to benign or clearly malignant ones[10]. Our study had relatively few borderline or indeterminate lesions (if any), which may lead to overestimation of ultrasound's diagnostic performance in such contexts.

Implications for Practice

Given the high diagnostic accuracy, ultrasonography should continue to be used as the first-line imaging modality in ovarian masses, especially in settings where MRI is less available or more costly. Adequate training of sonographers, using validated models like IOTA simple rules or ADNEX, can help reduce false positives and negatives. For cases where ultrasound findings are ambiguous (e.g. complex solid components, septations, papillary projections, borderline suspicion), MRI should be reserved.

Use of scoring systems (e.g. ADNEX, O-RADS ultrasound or MRI) may formalize risk stratification and reduce subjective variability. The meta-analysis of O-RADS Ultrasound revealed high sensitivity (~95%) for malignancy detection[12]. Integrating such model-based assessments would strengthen diagnostic workflows.

Furthermore, protocols for imaging referral should consider cost-effectiveness: ultrasound first, MRI follow-up only for indeterminate/complex cases. This approach can

preserve resources without compromising diagnostic confidence.

Future Research Directions

Future studies should aim to include histopathological confirmation for all cases to better estimate true diagnostic performance of ultrasound and MRI; especially for borderline tumors. Also, more multi-center studies across diverse settings are needed to assess generalizability.

Comparisons between subjective ultrasound assessment, formal models (ADNEX, O-RADS US), and MRI ORADS systems will help clarify which combination provides optimal balance of sensitivity and specificity. There is also increasing interest in artificial intelligence and machine learning applied to ultrasound images to improve diagnostic accuracy and reduce operator dependence.

Lastly, examining the economic implications and patient outcomes (e.g., time to diagnosis, morbidity from unnecessary referrals or surgeries) will help inform policy in resource-constraint settings.

Conclusion

Ultrasonography is a reliable, cost-effective, and widely available imaging modality with excellent diagnostic accuracy for malignant ovarian masses compared to MRI. It should continue to be used as the first-line investigation, while MRI should be reserved for indeterminate or complex lesions requiring further evaluation.

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