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Correlation of 2D Ultrasonography, Colour Doppler and Magnetic Resonance Imaging in the Evaluation of Adnexal Masses

Dr. Hardik Nigodia[1], Dr. Amlendu Nagar[2]

[1]Radiodiagnosis Resident
Email: *hardik.nigodia[at]gmail.com*

[2]Professor and HOD, Department of Radiodiagnosis

Abstract: ***Background**: Adnexal masses encompass a wide spectrum of benign and malignant ovarian pathologies. Accurate characterization is essential for appropriate management. This study evaluated the correlation between two-dimensional ultrasonography (USG), Colour Doppler, and magnetic resonance imaging (MRI) in the assessment of adnexal masses. **Methods**: This hospital-based cross-sectional study was conducted at a tertiary care teaching hospital that included 60 women with suspected adnexal masses. All patients underwent B-mode ultrasonography, Colour Doppler evaluation, and MRI. Morphological features, Doppler vascularity patterns, resistive index (RI), pulsatility index (PI), MRI enhancement characteristics, and diffusion-weighted imaging (DWI) findings were analyzed. MRI was used as the reference standard. Correlation analyses, diagnostic performance measures, and agreement statistics were calculated. **Results**: The mean age was 38.7 ± 13.4 years. Complex cystic morphology was the most common ultrasonographic pattern (35%). Peripheral vascularity was the predominant Doppler finding (33.3%), with a mean RI of 0.59 ± 0.15 and mean PI of 1.14 ± 0.36. MRI demonstrated no enhancement in 60% and no diffusion restriction in 60% of lesions. Significant correlations were observed between USG morphology and Doppler vascularity (χ^2=46.43, $p<0.0001$), USG features and MRI findings, including solid component versus enhancement (χ^2=32.18, p=0.0004) and diffusion restriction (χ^2=23.30, p=0.0001), as well as Doppler findings and MRI characteristics, including RI versus DWI/ADC (χ^2=37.75, $p<0.0001$) and vascularity pattern versus enhancement (χ^2=89.62, $p<0.0001$). USG demonstrated 73.3% diagnostic accuracy, whereas Colour Doppler showed 86.7% accuracy with 97.4% specificity. Agreement with MRI was moderate for USG (κ=0.450) and substantial for Colour Doppler (κ=0.686). **Conclusion**: A multimodal imaging approach integrating USG, Colour Doppler, and MRI provides complementary structural, haemodynamic, and functional information, significantly improving characterization of adnexal masses and diagnostic confidence.*

Keywords: Adnexal masses, Ultrasonography, Colour Doppler, Magnetic resonance imaging, Diffusion-weighted imaging, Ovarian lesions

1. Introduction

Adnexal masses are considered to be one of the most common clinical dilemmas faced in gynecological practice, which includes women of all ages and has a reported prevalence of 5-10% of the general population. [1] Distinguishing malignant from benign adnexal masses is a critical diagnostic challenge because it has direct implications for how we manage our patients, how we approach surgery, and what we expect in terms of outcome.

The use of Colour Doppler ultrasonography enhances grayscale ultrasound by providing information on tumor blood flow and vascularity. Malignant tumors typically show a chaotic, disorganized vascular network, lower resistance indices (RI < 0.4), and higher peak systolic velocities compared to benign tumors. [2] Combining morphological assessment with Doppler findings improves diagnostic accuracy, with reported sensitivity of 86–94% and specificity of 82–95% for malignancy. [3] However, overlap in Doppler features between benign and malignant tumors, particularly in premenopausal women due to hormonal variations, remains a limitation of this technique.

Magnetic resonance imaging (MRI) has emerged as a problem-solving tool when ultrasound findings of adnexal masses are indeterminate, offering excellent tissue differentiation and multi-planar imaging without radiation exposure. [4] The O-RADS MRI Score, developed by the European Society of Urogenital Radiology, standardizes risk assessment of adnexal masses based on morphology and signal characteristics. [5] Meta-analyses report a sensitivity of 92–94% and specificity of 85–88% for MRI in characterizing adnexal masses, with improved performance when combined with clinical and biochemical markers such as CA-125. [6] However, its routine use is limited by higher cost, reduced accessibility, longer examination times, and contraindications in some patients. [7]

The aim of the study is to assess the accuracy of ultrasound for the diagnosis of adnexal masses by comparing the results with the findings obtained through MRI scans and the value that the results obtained through Color Doppler ultrasound add to the findings obtained through ultrasound.

2. Materials and Methods

The hospital based cross-sectional study was conducted in the Department of Radiodiagnosis, Index Medical College Hospital and Research Centre, Indore, Madhya Pradesh, over a period of 18 months. A total of 60 patients fulfilling the inclusion criteria will be included in the study. The study was conducted in accordance to Declaration of Helsinki and was started after receiving ethical clearance from the Institutional Ethics Committee.

Inclusion Criteria

Female patients of pre-reproductive, reproductive, and postmenopausal age groups, referred with symptoms suggestive of adnexal masses such as pelvic pain, abdominal distension, gastrointestinal complaints, or unexplained weight loss, ready to provide written informed consent.

Exclusion Criteria
Pregnant women, Post-operative recurrence cases of adnexal masses, Masses confirmed to arise from uterus or other pelvic structures other than ovary, fallopian tube, or broad ligament, Patients with contraindications to MRI (Metallic implants, Cardiac pacemakers, Cochlear implants, Artificial heart valves, Metallic stents, Insulin/medical pumps)

3. Procedure

All eligible patients referred for evaluation of suspected adnexal masses will be enrolled after obtaining written informed consent. In the case of minors, consent will be obtained from parents or legal guardians. A detailed clinical history and relevant examination findings were recorded prospectively in a pre-structured proforma. Initial assessment was performed using transabdominal ultrasonography (USG) with GE Voluson S8 and LOGIQ P9 systems. Examinations were conducted in the supine position with a full urinary bladder, and images were acquired in sagittal, transverse, and oblique planes. The size, location, morphology (cystic, solid, or complex), septations, wall thickness, papillary projections, and internal echoes of adnexal masses were evaluated.

Subsequently, Color Doppler imaging was performed using the same ultrasound systems with high-frequency probes (3–8 MHz and 3–12 MHz). Doppler assessment included evaluation of lesion vascularity, flow pattern, resistive index (RI), pulsatility index (PI), and the presence of central or peripheral vascularity.

All patients underwent pelvic magnetic resonance imaging (MRI) on a 1.5-Tesla GE SIGNA Explorer scanner using a pelvic phased-array coil. The MRI protocol included sagittal and axial T1-weighted images, sagittal and axial T2-weighted images, coronal and axial T1 fast spin-echo localizer sequences, and contrast-enhanced sequences when indicated. MRI was utilized to characterize complex adnexal masses, assess internal architecture, evaluate local invasion, and determine involvement of adjacent structures.

Clinical, ultrasonographic, Color Doppler, and MRI findings were recorded in a predesigned data collection proforma and entered into Microsoft Excel. Statistical analysis was conducted using the SPSS version 22.0. Categorical variables will be expressed as frequency and percentage. Continuous variables will be expressed as mean ± standard deviation. Statistical significance was considered at p-value < 0.05.

4. Result

Table 1: Demographic and Clinical Characteristics of Patients with Adnexal Masses (n = 60)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (Years)	<20	3	5.0
	20–30	18	30.0
	31–40	14	23.3
	41–50	13	21.7
	51–60	8	13.3
	>60	4	6.7
Laterality of Adnexal Masses	Right	29	48.3
	Left	19	31.7
	Bilateral	12	20.0

Age statistics: Mean ± SD = 38.7 ± 13.4 years; Median = 36 years; Range = 14–70 years.

The majority of patients belonged to the 20-30 years (18, 30.0%) and 31-40 years (16, 26.7%) age groups, followed by 41-50 years (11, 18.3%). The mean age was 38.7 ± 13.4 years with a median of 35.5 years and range of 14-70 years. Patients younger than 20 years constituted the smallest group (3, 5.0%), while those above 60 years comprised 6.7%. Right-sided adnexal masses were most common, accounting for 29 cases (48.3%), followed by left-sided masses in 19 cases (31.7%). Bilateral involvement was observed in 12 cases (20.0%).

Table 2: Ultrasonographic Characteristics of Adnexal Masses (n = 60)

Parameter	Category	Frequency (n)	Percentage (%)
Morphology	Unilocular cystic	10	16.7
	Multilocular cystic	7	11.7
	Complex cystic	21	35.0
	Tubular cystic	7	11.7
	Solid-cystic / Complex	6	10.0
	Predominantly solid	8	13.3
	Not visualized	1	1.7
Wall Regularity	Regular	38	63.3
	Irregular	11	18.3
	N/A	11	18.3
Septation	Absent	32	53.3
	Regular	16	26.7
	Irregular	7	11.7
	N/A	5	8.3
Solid Component	Absent	29	48.3
	Present	26	43.3
	N/A	5	8.3
Papillary Projections	Absent	45	75.0
	Present	10	16.7
	N/A	5	8.3

Ultrasonography demonstrated a predominance of benign morphological features among adnexal masses. Complex cystic lesions were the most common morphological pattern (35.0%), followed by unilocular cystic lesions (16.7%). Regular walls (63.3%), absence of septations (53.3%), absence of solid components (48.3%), and absence of papillary projections (75.0%) were the predominant findings. Features typically associated with increased malignant potential, including irregular walls, irregular septations, solid components, and papillary projections, were observed in a smaller proportion of cases. Overall, the ultrasonographic profile suggested a predominance of benign adnexal lesions within the study population.

Table 3: Colour Doppler Characteristics of Adnexal Masses (n = 60)

Parameter	Category	Frequency (n)	Percentage (%)
Vascularity Pattern	No Flow	17	28.3
	Peripheral	20	33.3
	Central	11	18.3
	Central + Peripheral	6	10.0
	Septal	6	10.0
Resistive Index (RI)	<0.4	9	15.0
	0.4–0.5	8	13.3
	0.5–0.7	24	40.0
	>0.7	15	25.0
	N/A	4	6.7
Pulsatility Index (PI)	<1.0	19	31.7
	≥1.0	37	61.7
	N/A	4	6.7

RI: Mean ± SD = 0.59 ± 0.15; Range = 0.28–0.82
PI: Mean ± SD = 1.14 ± 0.36; Range = 0.48–1.95

Colour Doppler evaluation demonstrated peripheral vascularity as the most common flow pattern (33.3%), followed by absence of detectable flow (28.3%). Central and combined central-peripheral vascularity, which are more frequently associated with neoplastic angiogenesis, were observed in 28.3% of lesions. Most masses exhibited RI values between 0.5 and 0.7 (40.0%) or greater than 0.7 (25.0%), while low RI values (<0.4) were present in 15.0% of cases. Similarly, PI values ≥1.0 were observed in the majority of lesions (61.7%). Overall, Doppler findings were suggestive of predominantly benign vascular characteristics, with a subset of lesions demonstrating low-resistance flow patterns indicative of increased malignant potential.

Table 4: MRI Characteristics of Adnexal Masses (n = 60)

Parameter	Category	Frequency (n)	Percentage (%)
Post-Contrast Enhancement Pattern	No Enhancement	36	60.0
	Thin/Septal Enhancement	8	13.3
	Homogeneous Enhancement	1	1.7
	Moderate Enhancement	1	1.7
	Avid/Intense Enhancement	14	23.3
DWI/ADC Findings	No Restriction	36	60.0
	Mild Restriction	5	8.3
	Restricted Diffusion	19	31.7

MRI evaluation revealed no post-contrast enhancement in 60.0% of adnexal masses, indicating the predominance of simple cystic and benign lesions within the study population. Avid or intense enhancement was observed in 23.3% of cases, suggesting the presence of vascularized solid tissue components. On diffusion-weighted imaging, 60.0% of lesions demonstrated no diffusion restriction, whereas restricted diffusion was identified in 31.7% of cases, reflecting increased tissue cellularity. Collectively, MRI findings facilitated characterization of lesion composition and biological behavior, with enhancement and diffusion restriction serving as important indicators of lesions with a higher likelihood of malignancy.

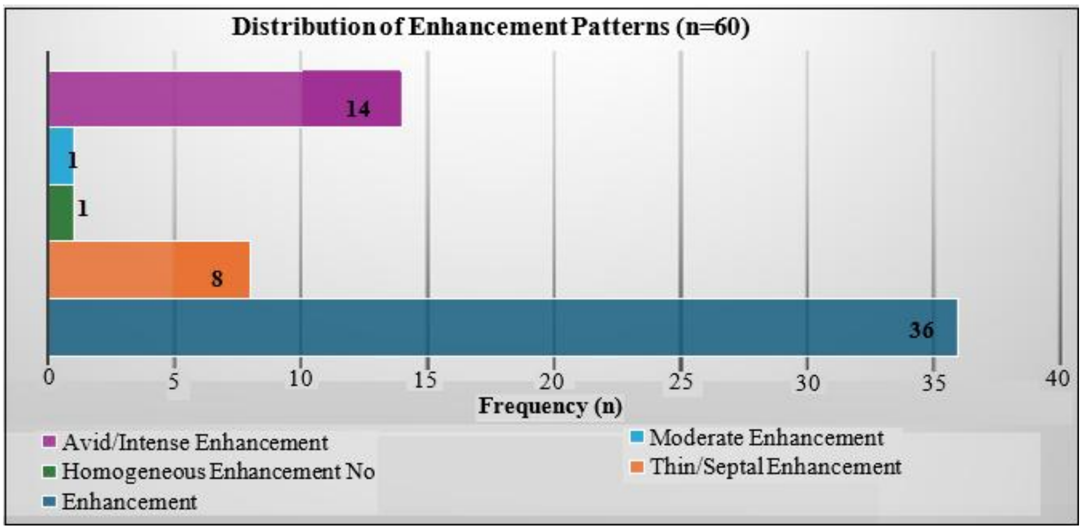

Figure 1: MRI Post-Contrast Enhancement Pattern (n=60)

Table 5: Correlation Between USG Morphology and Colour Doppler Findings

USG Morphology	No Flow n (%)	Peripheral n (%)	Central n (%)	Central + Peripheral n (%)	Septal n (%)	Mean RI ± SD
Unilocular Cystic (n=10)	6 (60.0)	4 (40.0)	0	0	0	0.69 ± 0.05
Multilocular Cystic (n=7)	0	0	0	1 (14.3)	6 (85.7)	0.59 ± 0.10
Complex Cystic (n=21)	8 (38.1)	9 (42.9)	3 (14.3)	1 (4.8)	0	0.67 ± 0.12
Tubular Cystic (n=7)	1 (14.3)	6 (85.7)	0	0	0	0.59 ± 0.10
Solid-Cystic / Complex (n=6)	0	0	2 (33.3)	4 (66.7)	0	0.35 ± 0.04
Predominantly Solid (n=8)	1 (12.5)	1 (12.5)	6 (75.0)	0	0	0.39 ± 0.08
Not Visualized (n=1)	1 (100)	0	0	0	0	0.62
Statistical Analysis						ANOVA: F = 14.6, p < 0.0001

Chi-square analysis for morphology versus vascularity pattern: $\chi^2 = 46.43$, $p < 0.0001$.

A significant association was observed between ultrasonographic morphology and Colour Doppler vascular characteristics ($\chi^2 = 46.43$, $p < 0.0001$). Predominantly cystic lesions, including unilocular, tubular, and complex cystic masses, mainly demonstrated absent or peripheral vascularity and relatively higher RI values, consistent with benign haemodynamic patterns. In contrast, solid-cystic and predominantly solid lesions exhibited central or combined central-peripheral vascularity with significantly lower mean RI values (0.35 ± 0.04 and 0.39 ± 0.08, respectively), indicating low-resistance blood flow. One-way ANOVA demonstrated significant variation in RI across morphological categories ($F = 14.6$, $p < 0.0001$). These findings suggest that increasing structural complexity and the presence of solid components on ultrasonography are associated with more abnormal vascular patterns and lower vascular resistance, features that may indicate a higher likelihood of malignancy.

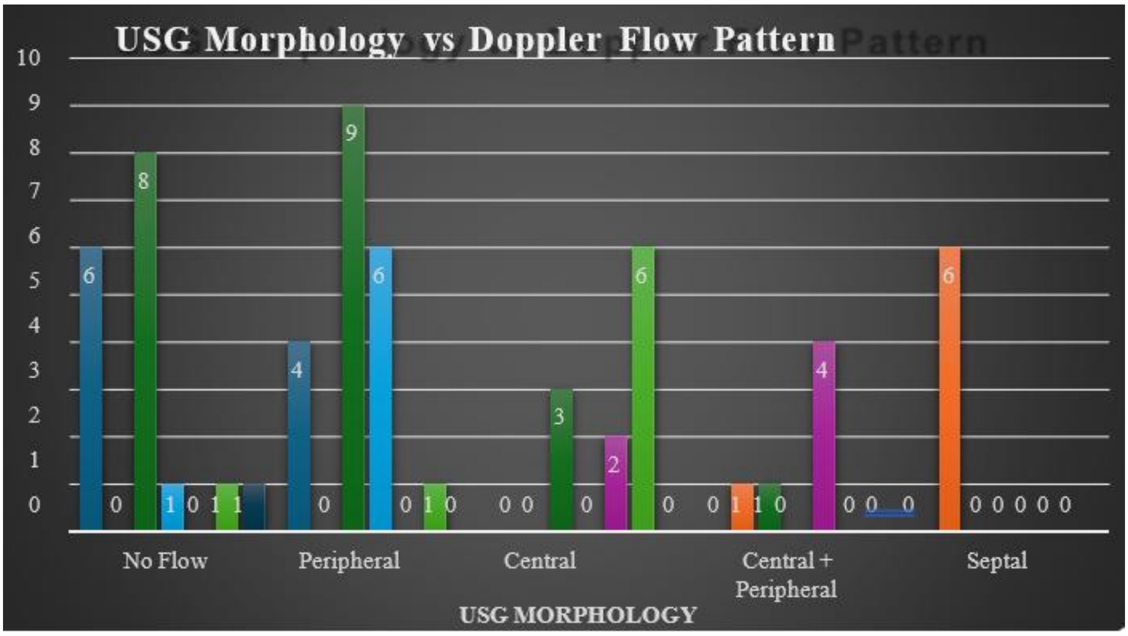

Figure 2: USG Morphology vs Colour Doppler Vascularity Pattern

Table 6: Correlation of Ultrasonographic Features with MRI Findings (n = 60)

USG Feature	Category	MRI Enhancement Pattern (No / Thin-Septal / Avid) n	MRI DWI/ADC Findings (No Restriction / Mild Restriction / Restricted) n	X²	P-value
Solid Component	Absent (n=29)	13 / 7 / 0	26 / 1 / 2	32.18*/23.30†	0.0004*/0.0001†
	Present (n=26)	5 / 1 / 14	10 / 3 / 13		
	N/A (n=5)	2 / 0 / 0	0 / 1 / 4		
Wall Regularity	Regular (n=38)	18 / 7 / 3	—	38.75	0.0001
	Irregular (n=11)	0 / 0 / 9	—		
	N/A (n=11)	2 / 1 / 2	—		
Morphology	Unilocular Cystic (n=10)	—	10 / 0 / 0	39.20	<0.0001
	Multilocular Cystic (n=7)	—	6 / 0 / 1		
	Complex Cystic (n=21)	—	15 / 2 / 4		
	Tubular Cystic (n=7)	—	5 / 1 / 1		
	Solid-Cystic / Complex (n=6)	—	0 / 0 / 6		
	Predominantly Solid (n=8)	—	0 / 2 / 6		
	Not Visualized (n=1)	—	0 / 0 / 1		

* Solid Component vs MRI Enhancement Pattern
† Solid Component vs MRI DWI/ADC Findings

Lesions with solid components demonstrated significantly higher frequencies of avid post-contrast enhancement and restricted diffusion compared with lesions lacking solid tissue ($p < 0.001$). Irregular wall morphology was strongly associated with avid enhancement, whereas regular-walled lesions predominantly exhibited absent or thin septal enhancement. Morphological analysis showed that unilocular and multilocular cystic lesions largely lacked diffusion restriction, while solid-cystic and predominantly solid lesions consistently demonstrated restricted diffusion. These findings indicate strong concordance between suspicious ultrasonographic features and MRI indicators of increased vascularity and cellularity, highlighting the complementary role of MRI in characterizing potentially malignant adnexal masses.

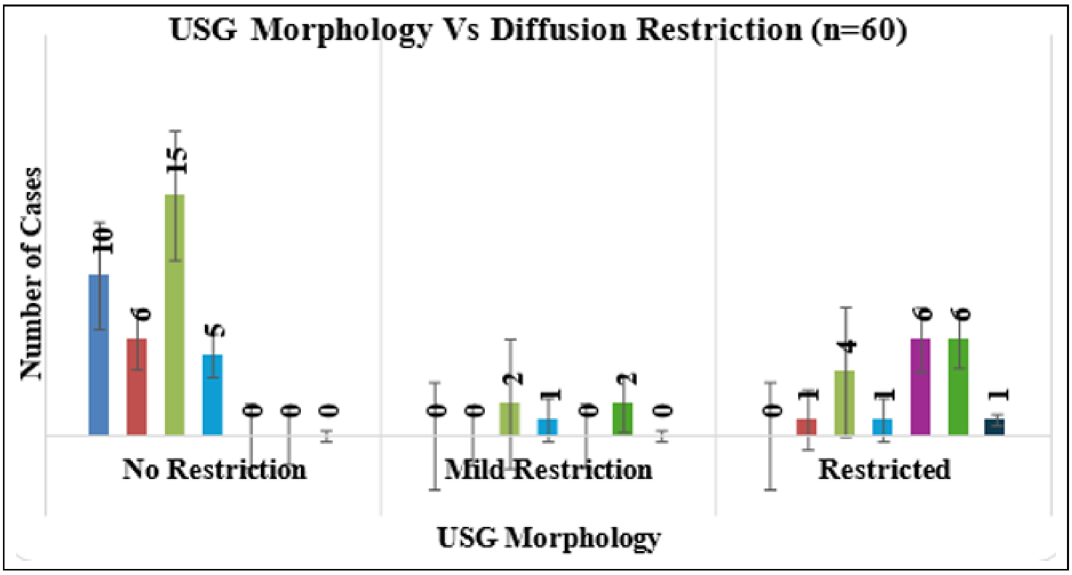

Figure 3: USG Morphology vs MRI DWI/AD

Table 7: Correlation Between Colour Doppler and MRI Findings (n = 60)

Colour Doppler Parameter	Category	MRI Enhancement Pattern (No / Thin-Septal / Avid) n	MRI DWI/ADC Findings (No Restriction / Mild Restriction / Restricted) n	χ^2	p-value
RI Category	<0.4 (n=9)	—	0 / 0 / 9	37.75	0.0001
	0.4–0.5 (n=8)	—	2 / 1 / 5		
	0.5–0.7 (n=24)	—	17 / 3 / 4		
	>0.7 (n=15)	—	15 / 0 / 0		
Vascularity Pattern	No Flow (n=17)	9 / 0 / 0	—	89.62	0.0001
	Peripheral (n=20)	10 / 3 / 0	—		
	Central (n=11)	0 / 0 / 11	—		
	Central + Peripheral (n=6)	0 / 0 / 6	—		
	Septal (n=6)	1 / 5 / 0	—		

A highly significant correlation was observed between Colour Doppler parameters and MRI findings. Low resistive index values (<0.4) were exclusively associated with restricted diffusion, whereas high RI values (>0.7) were consistently associated with absence of diffusion restriction (χ^2 = 37.75, p = 0.0001). Similarly, lesions demonstrating central or combined central-peripheral vascularity on Colour Doppler uniformly exhibited avid/intense contrast enhancement on MRI, while lesions with absent or peripheral vascularity predominantly showed no enhancement or only thin septal enhancement (χ^2 = 89.62, p = 0.0001). These findings indicate strong concordance between Doppler-derived haemodynamic characteristics and MRI markers of vascularity and tissue cellularity, supporting the complementary role of Colour Doppler and MRI in the characterization of adnexal masses.

Table 8: Diagnostic Performance and Agreement Analysis of Imaging Modalities (n = 60)

Modality / Comparison	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	McNemar χ^2	p-value	Cohen's Kappa (κ)	Interpretation
USG (B-mode) vs MRI	76.2	71.8	59.3	84.8	73.3	1.56	0.05	0.450	Moderate agreement
Colour Doppler vs MRI	66.7	97.4	93.3	84.4	86.7	—	—	0.686	Substantial agreement
USG + Colour Doppler vs MRI	76.2	71.8	59.3	84.8	73.3	1.56	0.005	0.450	Moderate agreement
USG vs Colour Doppler	—	—	—	—	—	—	—	0.579	Moderate agreement

MRI was considered the reference standard for diagnostic performance analysis.

Colour Doppler demonstrated the highest specificity (97.4%), positive predictive value (93.3%), diagnostic accuracy (86.7%), and agreement with MRI (κ = 0.686), indicating substantial concordance in lesion characterization. Although B-mode ultrasonography showed higher sensitivity (76.2%), its specificity and overall accuracy were lower than those of Colour Doppler. Agreement analysis revealed moderate concordance between USG and MRI (κ = 0.450) and between USG and Colour Doppler (κ = 0.579). These findings suggest that Colour Doppler provides valuable functional information that complements grayscale ultrasonography and exhibits the closest correlation with MRI findings in the evaluation of adnexal masses.

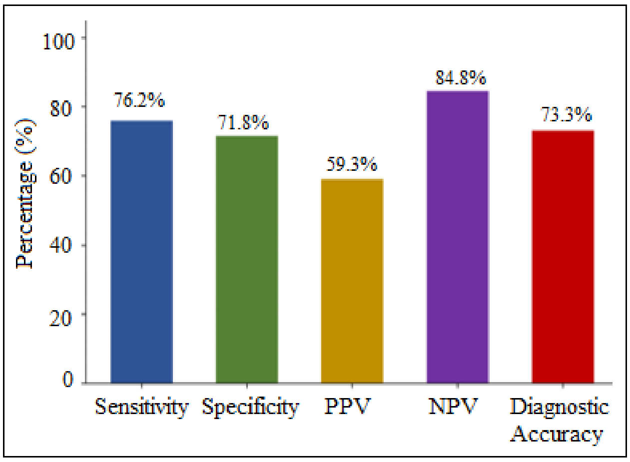

Figure 4: Diagnostic Accuracy of USG (B-mode) (MRI as Reference)

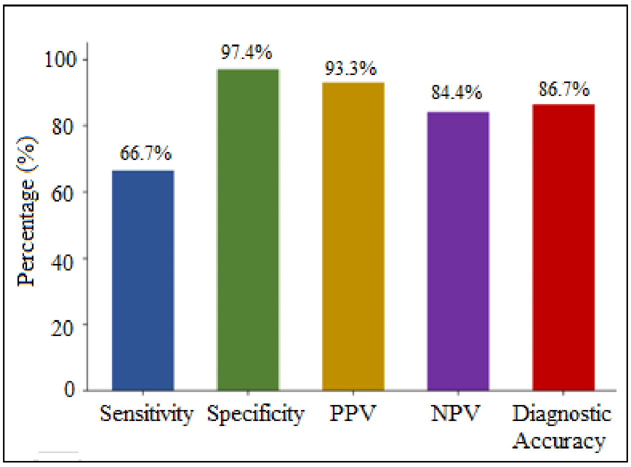

Figure 5: Diagnostic Accuracy of Colour Doppler (MRI as Reference)

5. Discussion

The present hospital-based cross-sectional observational study was conducted in 60 patients with suspected adnexal masses to evaluate the diagnostic performance of 2D ultrasonography (USG) and Colour Doppler, and to correlate these findings with magnetic resonance imaging (MRI), which was considered the imaging reference standard.

The mean age of patients in the present study was 38.7 ± 13.4 years, with the majority belonging to the 20–30 years (30%) and 31–40 years (23.3%) age groups. These findings are consistent with studies by Froyman et al. [1], Timmerman et al. [8], and Van Calster et al. [9], which reported that adnexal masses are most frequently encountered during the reproductive years. This predominance may be attributed to active ovarian physiology, including follicular development and ovulation, which predispose to the formation of functional and benign ovarian cysts. Right-sided lesions were more common (48.3%) than left-sided lesions (31.7%), while bilateral involvement was observed in 20% of cases, findings comparable to previous anatomical and imaging studies by Sokol [10] and Ezzati et al. [11]

On B-mode ultrasonography, complex cystic lesions constituted the largest morphological group (35%), followed by unilocular cystic lesions (16.7%). Regular wall morphology was observed in 63.3% of lesions, while papillary projections were present in only 16.7% of cases. These findings are in agreement with the IOTA studies reported by Timmerman et al. [8] and the O-RADS recommendations proposed by Andreotti et al. [12], which emphasize morphology as the cornerstone of adnexal mass characterization. The predominance of regular-walled and non-papillary lesions in the present study suggests a relatively higher proportion of benign masses within the study population.

Colour Doppler evaluation revealed peripheral vascularity as the most common flow pattern (33.3%), followed by absent flow (28.3%). The mean RI and PI values were 0.59 ± 0.15 and 1.14 ± 0.36, respectively. Lesions with low RI values (<0.4) were predominantly associated with complex and solid masses. Similar findings have been reported by Abbas et al. [2], Alcazar and Jurado [13], Shah et al. [14], and Abdelazim et al. [15] who demonstrated that increased internal vascularity and low-resistance flow patterns are frequently observed in lesions with greater structural complexity. These findings highlight the value of Doppler imaging in providing functional information beyond conventional morphological assessment.

MRI demonstrated no post-contrast enhancement in 60% of lesions and no diffusion restriction in 60% of cases. In contrast, avid enhancement and restricted diffusion were predominantly observed in solid and complex masses. These observations are consistent with the findings of Thomassin-Naggara et al. [16], who emphasized the role of MRI in characterizing indeterminate adnexal masses through superior tissue contrast and functional imaging. MRI findings in the present study further supported lesion characterization by differentiating simple cystic lesions from lesions with increased vascularity and cellularity.

A statistically significant association was observed between ultrasonographic morphology and Doppler vascularity pattern ($\chi^2 = 46.43$, $p < 0.0001$). Solid and solid-cystic lesions commonly demonstrated central or mixed vascularity, whereas unilocular and tubular cystic lesions predominantly showed peripheral or absent flow. Furthermore, mean RI values varied significantly across morphological groups ($F = 14.6$, $p < 0.0001$), with the lowest values observed in solid and solid-cystic lesions. Similar correlations have been reported by Testa et al. [3], Abbas et al. [2], and Acharya et al. [17] supporting the relationship between increasing structural complexity and altered vascular characteristics.

Significant correlations were observed between ultrasonographic features and MRI characteristics. The presence of solid components on USG was strongly associated with avid enhancement ($\chi^2 = 32.18$, $p = 0.0004$) and diffusion restriction ($\chi^2 = 23.30$, $p = 0.0001$) on MRI. Similarly, irregular wall morphology and complex lesion architecture demonstrated a higher frequency of MRI enhancement and restricted diffusion. These findings are consistent with studies by Thomassin-Naggara et al. [16], Forstner et al. [18], Mosavi et al. [19] confirming that structural abnormalities identified on ultrasound are often associated with functional alterations detectable on MRI.

A strong association was identified between Doppler vascularity and MRI findings. Central and mixed vascularity patterns were significantly associated with avid MRI enhancement ($\chi^2 = 89.62$, $p < 0.0001$), while low RI values were strongly correlated with diffusion restriction ($\chi^2 = 37.75$, $p < 0.0001$). These observations support the concept that Doppler-derived haemodynamic parameters reflect underlying tissue vascularity and cellularity. Similar findings have been reported by Abbas et al. [2], and Thomassin-Naggara et al. [16], who demonstrated a close relationship between tumour perfusion characteristics and MRI functional parameters.

Using MRI as the reference standard, B-mode ultrasonography demonstrated a sensitivity of 76.2%, specificity of 71.8%, and overall diagnostic accuracy of 73.3%. Colour Doppler showed lower sensitivity (66.7%) but markedly higher specificity (97.4%) and diagnostic accuracy (86.7%). Agreement analysis revealed moderate agreement between USG and MRI ($\kappa = 0.450$) and substantial agreement between Colour Doppler and MRI ($\kappa = 0.686$). These findings are comparable to the systematic reviews and meta-analyses conducted by Medeiros et al. [6], Zhang et al. [20] and Meys et al. [21] which demonstrated that the addition of Doppler significantly improves diagnostic confidence and specificity. Collectively, the findings support a multimodal imaging approach in which ultrasonography serves as the initial screening modality, Colour Doppler provides haemodynamic assessment, and MRI offers definitive characterization of indeterminate adnexal masses.

Despite the significant findings, this study had certain limitations. It was conducted at a single tertiary care center with a relatively small sample size (n=60), which may limit the generalizability of the results. The cross-sectional design precluded assessment of longitudinal changes and long-term outcomes of adnexal masses. Ultrasonography and Colour Doppler are operator-dependent modalities and may be influenced by inter-observer variability. Although MRI was used as the imaging reference standard, histopathological confirmation was not available for all cases, introducing the possibility of verification bias. Furthermore, advanced quantitative MRI parameters, such as detailed ADC mapping and dynamic perfusion analysis, were not comprehensively evaluated. Larger multicentric studies with histopathological correlation and long-term follow-up are warranted to validate and strengthen these findings.

6. Conclusion

Overall from the above study it can be concluded that a stepwise multimodal imaging approach integrating B-mode ultrasonography, Colour Doppler, and MRI provides comprehensive evaluation of adnexal masses. Ultrasonography serves as an effective screening modality, Colour Doppler refines haemodynamic interpretation, and MRI offers definitive structural and functional correlation in complex cases, thereby enhancing diagnostic confidence and supporting appropriate clinical management.

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