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Evaluation Of Diagnostic Accuracy Of Ultrasound And MRI In Differentiating Benign And Malignant Adnexal Masses With Cytohistopathological Findings As Gold Standard

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Abstract:
Background: *Adnexal mass lesions are common in women, with a prevalence of 0.17%-5.9% in asymptomatic individuals and 7.1%-12% in symptomatic women across all age groups. Diagnosing malignancy at an early stage remains challenging; However, early detection and timely intervention can significantly improve outcomes, especially in women of reproductive age.*
Aim*: To evaluate the diagnostic accuracy of Ultrasonography (USG) and Magnetic Resonance Imaging (MRI) in differentiating benign and malignant adnexal masses with cyto-histopathology as gold standard.*
Materials and methods*: A Cross-sectional study was conducted on 50 patients with suspected adnexal lesions, referred from the gynaecology outpatient department. The data was entered into a master chart and analysed using Statistical Package for the Social Sciences (SPSS)version20. Descriptive statistical measures including sensitivity, specificity, positive and negativepredictive values were calculated.*
Results: *Among patients aged 18 to 71 years (mean age 44.16 ± 13.6 years), 70% of adnexal masses were benign and 30% were malignant. Serous cystadenocarcinoma was the most common malignant lesion on histopathology. Serous cystadenoma was the most frequent finding on both ultrasound and MRI, followed by mucinous cystadenocarcinoma and dermoid cyst. While both modalities showedequal sensitivity (60%) for detecting malignancies, MRI demonstrated superior specificity (91.43% vs. 82.86%), positive predictive value (75% vs. 60%), and diagnostic accuracy (82% vs. 76%), indicating greater reliability in characterizing adnexal masses.*
Conclusion: *Ultrasound remains the preferred initial imaging modality for evaluating adnexal masses due to its accessibility, low cost, and real-time assessment capabilities. However, its limitations in specificity and positive predictive value underscore the need for further evaluation with MRI in indeterminate cases, as MRI offers higher accuracy and greater reliability in characterizing adnexal lesions.*
Keywords: *Adnexal lesions, Benign, Malignant, Ultrasonography, MRI, cyto-histopathology*

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I. Introduction

Anadnexal mass is a tissue mass in the adnexa of the uterus, the anatomical region adjacent to the uterus, that comprises the fallopian tubes, ovaries, associated vessels, ligaments and connective tissue. Because the fallopian tubes, ovaries and their mesenteries are so closely related anatomically, they are often collectively referred to asadnexa.[1]Adnexal masses, most commonly arising from the ovary or fallopian tube, can be of gynaecologic or non-gynaecologic origin and occur across all age groups with varying prevalence. They may result from physiological changes, inflammation, endometriosis, or benign and malignant tumors. Many adnexal masses are asymptomatic and remain undiagnosed, often being detected incidentally during physical

examinations or imaging studies. In some cases, they may present with acute or intermittent pain making differentiation from non-gynaecologic conditions essential[2]

Adnexal lesions are a common clinical problem and a significant cause of morbidity and mortality in the female population. The prevalence of adnexal masses ranges from 0.17% to 5.9% in asymptomaticwomen and 7.1% to 12% in symptomatic patients.[3]

Approximately 5–10% of women undergo surgery for suspicious adnexal lesions, though fewer than 25% of these lesions are malignant. While benign lesions often require simple excision, malignant lesionsnecessitate more radical surgical intervention. Accurate differentiation between benign and malignant lesions is crucial for guiding appropriate treatment, enabling timely subspecialty referral, effective preoperative planning, and proper patient counselling.[4]

Ultrasound is the first-line imaging modality for evaluating adnexal masses due to its accessibility and real-time imaging.[5] However, MRI is considered the investigation of choice due to its superior spatial and contrast resolution. MRI effectively characterizes pathological lesions and clearly delineates abnormalities in female reproductive organs, including ovarian masses, fibroids, adenomyosis, cervical lesions, and endometrial malignancies.[6]

Histopathology remains thegold standard for diagnosing malignancy, but its invasive nature can delay diagnosis and increase the healthcare burden.Although ultrasound and MRI are widely utilized, their comparative diagnostic accuracy against histopathology continues to be a subject of investigation. This study aims to evaluate and compare the accuracy of ultrasound and MRI in diagnosing adnexal masses, using histopathology as the reference standard.

II. Aim And Objective:

To evaluate the diagnostic accuracy of Ultrasonography (USG) and Magnetic Resonance Imaging (MRI) in differentiating benign and malignant adnexal masses with cyto-histopathology as gold standard.

III. Materials & Methods:

This cross-sectionalstudy was conducted in the Department of Radiology, in collaboration with the Department of Obstetrics and Gynaecology in a tertiary care teaching in northwestern Uttar Pradesh, and included 50 female patients who attended the Obstetrics and Gynaecology Outpatient Department with clinical symptoms suggestive of adnexal pathology such as lower abdominal pain, and were subsequentlyreferred to the Radiology Department for further evaluationfor a period of one year (January 2024 to December 2024).

Inclusion criteria:

1. All the patients aged 18 and above, clinically suspected of having adnexal masses andreferred from gynaecology outpatient department during the study period were included.

Exclusion criteria:

1. Patients with midline uterine mass lesions.
2. Patients who had previously undergone treatment for a pelvic mass
3. Clinically and USGconfirmed cases of ectopic pregnancy.
4. Patients with contraindications to MRI,including cardiac pacemakers, prosthetic heart valves, cochlear implants or other metallic implants.
5. Patients with contraindications to MRI contrast study
6. Patients without histopathological correlation
7. Patients unwilling to participate in the study.

Data Collection method and imaging protocols:

All patients underwent a detailed clinical evaluation, including history-taking and physical examination, as per the clinical proforma. Eligible cases were enrolled after obtaining informed consent and were instructed to fast for 4–6 hours before imaging. Each patient underwent ultrasound followed by MRI within one week. USG was used to assess the aetiology of adnexal mass using ACUSON S2000 and ACUSON JUNIPER USG machines and findings were documented. MRI was performed usingSiemens Skyra 3 tesla wide bore 48 channel MR scanner and Siemens Sempra 1.5 tesla 18 channel using multiple sequences (T1 axial, T2 sagittal and coronal, T1 contrast axial and coronal, and STIR coronal) for further evaluation. The need for surgical intervention was determined by a gynaecologist. Imaging findings were then compared with histopathological results.

Ethical considerations: Institutional ethics committee approval was obtained prior to starting the study.

Statistical analysis: The data was collected into Microsoft Office Excel 2010 and subsequently exported to SPSS version 20.0 for analysis. The USG and MRI findings for eachsubject werecompared with the final diagnosis. Descriptive statistics including frequency and percentage analysis were used for categorical variables while the mean &the standard deviation (SD) were used for continuous variables. Diagnostic performance metrics includingsensitivity, specificity, andpredicativevalues were calculated.

IV. Results

The mean age of the study population was 44.16±13.6 yearswith ages ranging from 18 to 71 yrs. In the present study, majority of participants presenting with adnexal lesions were in the41–50-year age group followed by those in the 31–40-year age group.

Approximately68% of the study population were premenopausaland 32% were post-menopausal. The most common presenting complaint among patients was the presence of a lump (88%), followed by abdominal distension (78%), pain (74%), and abnormal bleeding (36%).

Ultrasound characteristics revealed that 86% of patients had a single lesion, while 14% had multiple lesions. In terms of laterality, 86% of lesions were unilateral and 14% were bilateral.Regarding the lesion type, 54% were cystic, 8% were solid, and 38% were solid-cystic. The echogenicity findings showed that 48% were hypoechoic, 36% were hyperechoic, 12% were hyperechoic with internal echoes, and 4% were isoechoic.Septations were present in 16% of cases and absent in 84%. Vascularity was detected in 48% and absent in 52%. Papillary projections were observed in 30% of cases. Ascites was noted in 26% of patients.

MRI evaluation of adnexal lesions revealed a variety of signal characteristics and structural appearances. On T1-weighted images, 44% were hypointense, 42% hyperintense, and 14% isointense; on T2-weighted images, 44% were isointense, 42% hyperintense, and 14% hypointense. Fat planes were preserved in 76% of cases, mildly obliterated in 6% and completely obliterated in 18%. Contrast enhancement was absent in 52%, mild in 26%, and definite in 22% of lesions. In terms of overall appearance, 58% of lesions appeared homogeneous, while 42% were heterogeneous. These findings underscore MRI's value in assessing lesion composition, enhancement, and local invasion-crucial for accurate diagnosis and treatment planning.

From the 50 cases analysed, on ultrasound most common diagnosis was serous cystadenoma, (16%), followed by mucinous cystadenocarcinoma (14%) and both dermoid cysts and serous cystadenocarcinoma (12% each). In this study 70% of the adnexal lesions diagnosed by ultrasound were benign and 30% were malignant.

MRI findings also identified serous cystadenoma as the most common adnexal mass (18%), followed by dermoid cysts, mucinous cystadenoma, and serous cystadenocarcinoma (10% each). Less common diagnoses included endometriomas, mucinous cystadenocarcinomas, and subserosal fibroids accounted for 8% of cases each, germ cell tumors, haemorrhagic cysts, and peritoneal inclusion cysts (6% each), Hematosalpinx and tubo-ovarian abscess (4% each), with ovarian torsion being the rarest at 2%.

In a study of 50 adnexal lesions, ultrasound identified 35 as benign and 15 as malignant. Compared to histopathology, it correctly diagnosed 29 benign and 9 malignant cases, with 6 false positives and 6 false negatives. Ultrasound showed a sensitivity of 60%, specificity of 82.86%, PPV of 60%, NPV of 83%, and an overall diagnostic accuracy of 76%.

MRI identified 38 cases as benign of which 32 were confirmed as benign on histopathology. while 6 cases were actually malignant (false negative), indicating that MRI missed these cancers.On the other hand, MRI labelled 12 cases as malignant, with 9of these were truly malignant based on histopathology (true positive). The remaining 3 cases were actually benign (false positive), meaning MRI incorrectly classified them as cancer.

MRI demonstrated high specificity (91.43%) and diagnostic accuracy (82%) in differentiating benign from malignant adnexal lesions, making it a reliable tool for identifying benign cases and reducing unnecessary surgeries. Although sensitivity remained moderate (60%), likely due to overlapping imaging features in certain malignancies, MRI showed higher PPV (75%) and NPV (84.21%), indicating greater reliability in confirming or ruling out malignancy. Compared to ultrasound, MRI had the same sensitivity but outperformed in specificity, PPV, and overall diagnostic accuracy, indicating superior reliability in characterizing adnexal masses

Table 1: Diagnosis based on Ultrasound, MRI and Histopathological examination

	ULTRASOUND DIAGNOSIS Frequency (%)	MRI DIAGNOSIS Frequency (%)	HPE DIAGNOSIS
Dermoid Cyst	6(12%)	5(10%)	5(10%)
Endometrioma	4(8%)	4(8%)	4(8%)
Germ Cell tumor	2(4%)	3(6%)	3(6%)
Hematosalpinx	2(4%)	2(4%)	2(4%)
Hemorrhagic Cyst	4(8%)	3(6%)	3(6%)
Mucinous cystadenocarcinoma	7(14%)	4(8%)	5(10%)
Mucinous cystadenoma	2(4%)	5(10%)	4(8%)

Ovarian Torsion	1(2%)	1(2%)	1(2%)
Peritoneal inclusion cyst	2(4%)	3(6%)	3(6%)
Serous cystadenocarcinoma	6(12%)	5(10%)	7(14%)
Serous cystadenoma	8(16%)	9(18%)	7(14%)
Sub Serosal fibroid	4(8%)	4(8%)	4(8%)
Tubo-ovarian Abscess	2(4%)	2(4%)	2(4%)
Total	50	**50**	**50**

Table 2: Diagnostic accuracy OfUltrasound and MRI compared with Cyto-histopathology

	Sensitivity	Specificity	PPV	NPV	Accuracy
ULTRASOUND	60%	82.86%	60%	83%	76%
MRI	60%	91.43%	75%	84.21%	82%

V. Discussion:

This studyconducted on 50 female patients with suspected adnexal lesions aimed to assess the diagnostic accuracy of ultrasound (USG) and MRI in differentiating benign from malignant lesions. Imaging findings were analysedand correlated with cyto-histopathological results to evaluate the effectiveness of both modalities in lesion characterization.

The mean patient age was 44.16 years, with majority in the 41–50 age group. These findings are consistent with studies by Kumar PB et al[7]and partially with Chinta VP et al[8] and Ramya T et al[9], who also reported high incidence in similar age ranges. Though some studies such as those by Shiva Shankar MP et al[10], Aruna K et al[6], and Al-Shukriet al[11] reported lower mean ages (29–32 years), reflecting higher prevalence of benign lesions in youngerwomen. Conversely, Adusumilliet al[12] observed a higher mean age, aligning with increased malignancy rates in postmenopausal women.

The most common clinical presenting symptom in this study was a palpable lump (88%), followed by abdominal distension (78%), pain (74%), and abnormal bleeding (36%). These findings align with previous studies Debbarma T et al[13], Prasad CV et al.[8], Shiva Shankar MP et al[10], Guzel et al[14] and Al-Shukri et al[11] thoughsome reported pain as most frequentsymptom. The age distribution, primarily 21–40 years, and symptom profile are largely consistent with earlier research, with variations reflecting differences in lesion types (benign vs. malignant).

Ultrasonography and MRI findings from Shiva Shankar MP et al.[10] showed that 78.33%of lesions were cystic and 21.67% solid-cystic withseptal wall thickness <3mm in most cases andnodules were absent in most cases (86.67% on USG and 81.67% on MRI). Ascites was seen in 91.67% of cases. In terms oflaterality, (43%) were right-sided, and45% left-sided and 12% bilateral.

In our study, 86% of ovarian lesions were unilateral and 14% bilateral, consistent with Kumar PB et al.[7](80% unilateral) and Prasad CVet al.[8](12% bilateral), though Lovely Kaushal et al.[15]reported a higher bilateral involvement (42%).

Lesions were cystic in 54% of cases, solid in 8 %, and solid-cystic in 38%, with ascites in 26%. Prasad CV et al[8] reported a higher percentage of cystic lesions (78.33%) and ascites (91.67%). Aruna et al[6] noted 50% cystic, 18% solid, and 32% complex lesions, while Prabha et al[16] found 66% solid and 42% complex lesions, with no purely cystic lesions.

In this study ultrasound most commonly diagnosed serous cystadenoma (16%) and mucinous cystadenocarcinoma (14%), with benign lesions making up 70 % and malignant 30 %. Ultrasound had 60% sensitivity, 82.86% specificity, 60% PPV, 82.86% NPV, and 76% accuracy. Prasad CVet al[8] reported 64.4% sensitivity, 100% specificity, 100% PPV, 84.2% NPV, and 81.49% diagnostic accuracy. Shiva Shankar MP et al[10] found higher sensitivity and specificity of 92.5% and 93.3%, respectively. Aruna et al[6] reported sensitivity and specificity of 80% and 95%, while Madan R et al[17] noted a sensitivity of 92.5% but lower specificity of 55.3%. Ramya T et al[9] observed sensitivity of 58.3%, specificity 100%, PPV 100%, NPV 86.85%, and diagnostic accuracy 79.15%. Sultana N et al[18] found transabdominal USG sensitivity of 100%, specificity 54%, PPV 58.5%, and NPV 100%.

Ultrasound demonstrated good specificity (82.86%) but moderate sensitivity (60%) in differentiating benign from malignant lesions with a diagnostic accuracy of 76%. it remains a valuable, non-invasive first-line tool, though limited by operator dependence and difficulty in assessing borderline or complex masses.

In our study MRI showed higher specificity (91.43%) and diagnostic accuracy (82%) compared to ultrasound, though both had equal sensitivity (60 %). In Sultana N et al[18] study, sensitivity, specificity, PPV and NPV for contrast enhanced MRI, was 95.8%, 86.4%, 82.1% and 96.9% respectively. Mugheri FN et al[19] showed that contrast enhanced MRI was more accurate investigation as compared to transabdominal doppler USG for differentiating the malignant and benign adnexal masses. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of contrast enhanced MRI were 94.83%, 87.50%, 93.22%, and 92.22% respectively which were similar with Kasim A et al[20]

In a study involving 161 subjects, Guerra et al[21] reported that MRI demonstrated a 95% accuracy in differentiating between malignant and non-malignant lesions. Additionally, Dodgeet al [22] found that the sensitivity and specificity of MRI in detecting malignant lesions could reach up to 92% and 88%, respectively.

The present study demonstrates that MRI is more reliable for preoperative evaluation, especially when ultrasound results are inconclusive. It supports prior evidence of MRI's superiority in characterizing adnexal lesions, aiding clinical decision-making and surgical planning.

VI. Limitations:

The small sample size and single center nature of this study may limit the generalizability of the findings. Further research with large populations is recommended.

VII. Conclusion:

Ultrasound is a valuable first-line imaging modality due to its availability and cost-effectiveness, However, its limited specificity and PPV make it less reliable in complex or borderline cases. MRI, with its superior soft tissue contrast and higher diagnostic accuracy is more effective for evaluating indeterminate lesions or suspected malignancies.

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