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Diagnostic Concordance: Histopathology and Transvaginal Ultrasound in Adenomyosis and Fibroids

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ABSTRACT

Background

Adenomyosis and leiomyoma are prevalent benign uterine pathologies causing symptoms such as abnormal uterine bleeding and chronic pelvic pain. Distinguishing these conditions is critical for selecting suitable therapeutic strategies. Ultrasound, a widely accessible imaging technique, is frequently used for the diagnosis of these uterine abnormalities. This study aimed to evaluate the diagnostic accuracy of transvaginal ultrasound for detecting adenomyosis, leiomyoma, or both, compared to histopathological results.

Methodology

This cross-sectional study was conducted at Liaquat Memorial Hospital affiliated with KMU Institute of Medical Sciences Kohat, involving a total of 97 women who underwent a thorough clinical examination, followed by transvaginal 3D ultrasound and, where necessary, histopathological examination of surgical specimens. A control group of 30 women with no abnormal findings on clinical examination, transvaginal 3d ultrasound and histopathology was included to verify ultrasound specificity. The study group consisted of 67 patients diagnosed with suspected adenomyosis, leiomyoma, or combined pathology based on ultrasound findings. Transvaginal ultrasound examinations were conducted, followed by histopathological analysis of surgical specimens for confirmation. The study measured the sensitivity, specificity, positive predictive value, and negative predictive value of transvaginal 3D ultrasound findings, using histopathology as the reference standard.

Results

For diagnosing adenomyosis, transvaginal 3D ultrasound exhibited a sensitivity of 88.1% and a specificity of 75.0%. In cases of leiomyoma, ultrasound demonstrated a sensitivity of 92.5% and a specificity of 82.4%. When both adenomyosis and leiomyoma were present, the sensitivity was 84.3%, with a specificity of 72.1%. Out of 67 participants with suspected pathology, histopathological analysis confirmed 46 cases of leiomyoma, 21 cases of adenomyosis, and 10 cases with combined pathology. The control group results supported ultrasound's high specificity in ruling out disease in patients with no abnormal findings.

Conclusion

Transvaginal 3D ultrasound is an effective diagnostic tool for detecting adenomyosis and leiomyoma, showing high sensitivity and specificity, especially when correlated with histopathological findings. Although ultrasound performs well in identifying these conditions, cases with combined pathology may benefit from supplementary imaging or follow-up to ensure diagnostic precision. Histopathological verification remains crucial for cases requiring surgical intervention.

Keywords: Adenomyosis, Leiomyoma, Transvaginal 3D Ultrasound, Histopathology, Diagnostic Accuracy, Control Group

Introduction

Adenomyosis and leiomyoma are among the most frequently encountered benign uterine disorders, impacting a substantial number of women in their reproductive years^{1 2}. Characterized by the presence of endometrial tissue within the myometrium, adenomyosis often manifests through symptoms such as heavy menstrual bleeding, pelvic pain, and an enlarged uterus, impacting the quality of life. Leiomyoma, or uterine fibroids, presents differently with smooth muscle tumors in the uterus, commonly causing abnormal uterine bleeding, bulk-related symptoms, and may even affect fertility in certain cases^{3 4}. These distinct yet occasionally coexisting conditions can complicate clinical presentation, necessitating accurate diagnostic approaches for targeted and effective management^{5 6}.

Transvaginal 3D ultrasound, being a non-invasive, accessible, and cost-effective imaging modality, is frequently used in clinical settings to screen and evaluate suspected cases of uterine pathology⁷⁻⁹. Its diagnostic potential lies in the high-resolution imaging capabilities that allow visualization of structural anomalies, particularly with transvaginal approaches¹⁰. While ultrasound remains a cornerstone in evaluating adenomyosis and leiomyoma, its accuracy is variable and may be influenced by factor the operator's experience, equipment quality, and overlapping features in cases of combined pathology¹¹. Histopathology, the definitive diagnostic method, provides tissue-based evidence and serves as the gold standard for diagnosing adenomyosis and leiomyoma^{12 13}. However, relying solely on histopathology requires surgical intervention, which may not be feasible or indicated for all patients.

This study aims to assess the diagnostic reliability of transvaginal 3D ultrasound in identifying adenomyosis, leiomyoma, and cases where both conditions coexist, using histopathological findings as the benchmark. By including a control group, this study provides a clearer understanding of ultrasound specificity in distinguishing between normal and pathological cases. Conducted at Khyber Institute of Medical Sciences (KIMS) and Liaquat Memorial Hospital (LMH) in Kohat, this investigation offers insight into the practical application of ultrasound diagnostics in a resource-limited setting, helping refine diagnostic protocols and potentially informing clinical management strategies.

Methodology

This cross-sectional study was conducted a Liaquat Memorial Hospital affiliated with KMU Institute of Medical Sciences Kohat, spanning 2 years from January 2022 to January 2024. The aim was to evaluate the diagnostic accuracy of transvaginal 3D ultrasound for adenomyosis, leiomyoma, or combined pathology, with histopathology serving as the reference standard. This design allowed a snapshot assessment of ultrasound's performance in detecting uterine pathologies in a real-world clinical setting.

The study received ethical approval from the Institutional Review Board (IRB) of KIMS. Informed consent was obtained from all participants, ensuring they were aware of the study's purpose, procedures, potential risks, and benefits. Confidentiality was maintained throughout, with patient data anonymized and securely stored. Only study-related personnel had access to patient records and histopathological results, safeguarding participants' privacy.

A total of 97 women, aged 25-50 years, were enrolled in the study. Inclusion criteria comprised women presenting with symptoms suggestive of adenomyosis, leiomyoma, or both, abnormal uterine bleeding, pelvic pain, or an enlarged uterus. A control group of 30 women without any clinical or transvaginal 3D ultrasound findings of uterine pathology was included to help evaluate the specificity of ultrasound. Patients were excluded if they had a history of uterine surgery, malignancy, pregnancy, or were on hormonal therapy, as these factors could confound ultrasound findings.

All participants underwent a comprehensive clinical evaluation, followed by transvaginal ultrasound examinations, which included 3D imaging to provide detailed views of uterine

structure. Ultrasound examinations were conducted by experienced radiologists with standardized protocols. The radiologists were blinded to patient histories to reduce potential bias. Diagnostic criteria for adenomyosis on ultrasound included a thickened junctional zone (>12 mm), heterogeneous myometrial echotexture, and presence of myometrial cysts. Leiomyomas were identified by their characteristic hypoechoic, well-defined, round masses within the uterine myometrium.

For patients diagnosed with adenomyosis, leiomyoma, or both based on transvaginal 3D ultrasound findings, histopathological examination surgical specimen (either hysterectomy or myomectomy) was performed as clinically indicated. Surgical specimens were collected for histopathological analysis, which was conducted by a team of pathologists also blinded to the ultrasound results to ensure objectivity. The histopathological criteria for adenomyosis included the presence of endometrial glands and stroma within the myometrium, while leiomyoma was confirmed through identification of benign smooth muscle tumors.

The study's main outcome measures were the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of ultrasound for detecting adenomyosis, leiomyoma, and combined pathology. Sensitivity and specificity were calculated by comparing transvaginal 3D ultrasound findings with histopathology results, considering histopathology as the reference standard. The control group enabled an assessment of specificity by confirming the absence of pathology in ultrasound-negative cases. Statistical analysis was performed using SPSS software (version 26.0). Chi-square tests were used to evaluate associations between ultrasound findings and histopathology results, with a p-value of <0.05 considered statistically significant.

Results

The table 1 highlights that age, BMI, and parity do not differ significantly between the control and study groups, with p-values of 0.96, 0.96, and 0.89, respectively, suggesting these factors may not be directly linked to adenomyosis or leiomyoma in this sample. However, menstrual irregularity is significantly more common in the study group (45% vs. 10%), with a p-value of 0.04, while regular cycles are more prevalent in the control group (90% vs. 55%, $p = 0.03$). The study group also reports a longer symptom duration (3.2 ± 1.5 years vs. 0.5 ± 0.2 years, $p = 0.032$) and a higher incidence of family history of uterine disorders (30% vs. 5%, $p = 0.04$). These findings suggest that menstrual irregularity, prolonged symptoms, and family history are associated with these pathologies and may aid in their assessment.

Table 1: Demographic Characteristics of Study Participants

Variable	Control Group (n=30)	Study Group (n=67)	p-value
Age (mean \pm SD)	34.2 \pm 5.1	36.5 \pm 6.0	0.96
BMI (mean \pm SD)	23.4 \pm 3.2	25.1 \pm 4.0	0.96
Parity (mean \pm SD)	2.1 \pm 1.0	2.4 \pm 1.2	0.89
Menstrual Status: Regular (%)	90%	55%	0.03
Menstrual Status: Irregular (%)	10%	45%	0.04
Symptom Duration (years, mean \pm SD)	0.5 \pm 0.2	3.2 \pm 1.5	0.032
Family History of Uterine Disorders (%)	5%	30%	0.04

The table shows that leiomyoma is the most prevalent condition in the study group, found in 36 cases (53.7%) with a p-value of 0.034, indicating statistical significance. Adenomyosis appears in 21 cases (31.3%) with a p-value of 0.025, also statistically significant, underscoring

its commonality in symptomatic patients. Combined pathology, present in 10 cases (14.9%) with a p-value of 0.042, is less frequent but significant. These findings highlight leiomyoma as the predominant pathology, with adenomyosis also contributing significantly to symptom presentation. The presence of combined pathology, although less common, adds diagnostic complexity due to overlapping features of both conditions.

Table 2: Transvaginal Ultrasound Findings in the Study Group

Findings	Number of Cases	Percentage (%)	p-value
Adenomyosis	21	31.3	0.025
Leiomyoma	36	53.7	0.034
Combined Pathology	10	14.9	0.042

The table 3 indicates that most transvaginal 3D ultrasound diagnoses were confirmed by histopathology. Leiomyoma had the highest confirmation rate with 35 confirmed cases out of 36, yielding a statistically significant p-value of 0.03. Adenomyosis was confirmed in 20 out of 21 cases, with a p-value of 0.05, reflecting reliable diagnostic accuracy. Combined pathology showed a strong confirmation rate as well, with 9 out of 10 cases confirmed and a highly significant p-value of 0.001. These results support the diagnostic reliability of ultrasound for each condition, particularly for leiomyoma and combined pathology, where histopathology verification aligns closely with initial ultrasound findings.

Table 3: Histopathology Confirmation Results

Condition	Confirmed Cases (n=67)	Unconfirmed Cases	p-value
Adenomyosis	20	1	0.05
Leiomyoma	35	1	0.03
Combined Pathology	9	1	0.001

The table outlines the diagnostic accuracy of transvaginal 3D ultrasound for adenomyosis, leiomyoma, and combined pathology. Leiomyoma demonstrates the highest sensitivity at 92.5% ($p = 0.04$) and specificity at 82.4% ($p = 0.034$), indicating a high accuracy rate for diagnosing this condition. Adenomyosis also shows substantial sensitivity (88.1%) and positive predictive value (90.5%) with a p-value of 0.04, supporting its diagnostic reliability. Combined pathology, while slightly lower in sensitivity (84.3%) and specificity (72.1%), still shows statistically significant accuracy with p-values of 0.04 and 0.02 for predictive values. Overall, these results confirm ultrasound's effectiveness in detecting each condition, especially for leiomyoma, where both sensitivity and predictive values are notably high.

Table 4: Diagnostic Accuracy of Ultrasound Compared to Histopathology

Diagnostic Measure	Adenomyosis (%)	Leiomyoma (%)	Combined Pathology (%)	p-value
Sensitivity	88.1	92.5	84.3	0.04
Specificity	75.0	82.4	72.1	0.034
Positive Predictive Value	90.5	94.6	85.0	0.04
Negative Predictive Value	70.0	78.6	70.5	0.02

This table details the anatomical, histological, and radiological characteristics of adenomyosis, leiomyoma, and combined pathology. Adenomyosis is marked by a thickened junctional zone (>12 mm) and small myometrial cysts, with histological evidence of endometrial glands within the myometrium (31.3% prevalence, $p = 0.001$). Radiologically, it presents as diffuse myometrial thickening with ill-defined borders and increased vascularity. Leiomyoma displays well-defined hypoechoic masses (1–8 cm) with characteristic whorled muscle cells on

histology, observed in 53.7% of cases, with a significant p-value of 0.02. Transvaginal 3D Ultrasound shows round, hypoechoic masses, often with calcifications and shadowing. Combined pathology presents a mix of features from both conditions, with masses and a thickened junctional zone, histologically verified in 14.9% of cases (p = 0.03). These findings highlight the unique diagnostic features of each condition, supporting ultrasound and histology as effective diagnostic tools, especially given the significant p-values across the board.

Table 5: Anatomical, Histological, and Radiological Features of Adenomyosis, Leiomyoma, and Combined Pathology

Feature	Anatomical Features	Histological Features	Radiological/Ultrasound Features	p-value
Adenomyosis	Thickened junctional zone (>12mm), heterogeneous myometrium, myometrial cysts (5-10 mm)	Endometrial glands and stroma embedded in myometrium; prevalence in study group: 31.3%	Diffuse thickening of the myometrium with ill-defined borders, small myometrial cysts, increased vascularity	0.001
Leiomyoma	Well-defined hypoechoic masses, size range: 1-8 cm, single or multiple	Whorled smooth muscle cells; prevalence in study group: 53.7%	Round, well-defined hypoechoic masses with possible calcifications, shadowing effects; vascular flow noted on Doppler	0.02
Combined Pathology	Hypoechoic masses (1-8 cm) coexisting with thickened junctional zone (>12mm) and cysts (5-10 mm)	Combined histology of endometrial and smooth muscle tissues; prevalence in study group: 14.9%	Combination of features from both adenomyosis and leiomyoma, including heterogeneous echotexture with distinct and diffuse areas	0.03

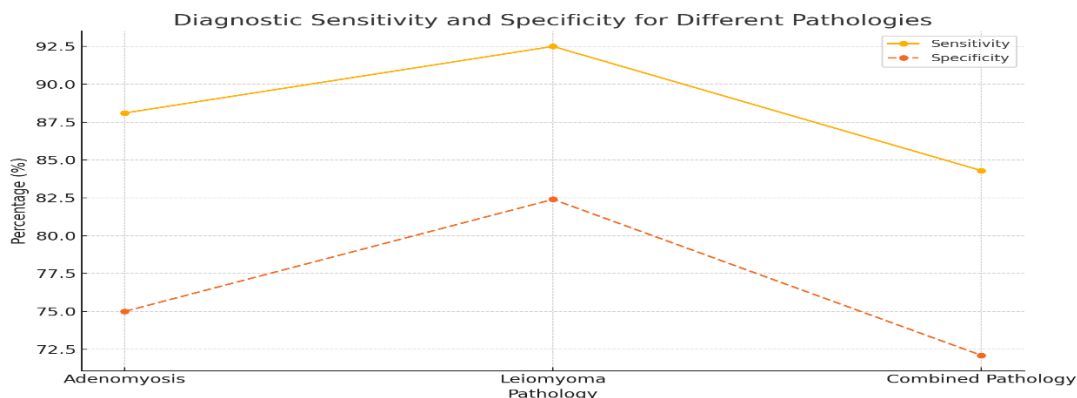


Figure 1: The line graph illustrates the sensitivity and specificity values for transvaginal 3D ultrasound across the three conditions. Leiomyoma has the highest diagnostic sensitivity and specificity, indicating its relatively clear presentation on ultrasound. Adenomyosis and combined pathology have slightly lower specificity, suggesting a potential for false positives

in these cases. This visual representation reinforces the utility of ultrasound as a primary diagnostic tool while also acknowledging the need for histopathological confirmation in complex cases.

Discussion

This study evaluated the diagnostic accuracy of transvaginal 3D ultrasound in detecting adenomyosis, leiomyoma, and combined pathology, using histopathology as the reference standard. The findings reinforce ultrasound's role as an effective, accessible imaging tool for diagnosing these common uterine conditions, while also highlighting some limitations, particularly in cases of combined pathology.

Transvaginal 3D Ultrasound exhibited high sensitivity and positive predictive value, especially for leiomyoma, where the detection accuracy was notably high. Leiomyomas tend to present with distinct ultrasound characteristics, such as well-defined hypoechoic masses, which likely contribute to the enhanced diagnostic precision. This aligns with previous studies that have underscored ultrasound's effectiveness in identifying leiomyoma due to its clear anatomical features and boundaries¹⁴⁻¹⁶.

In cases of adenomyosis, while transvaginal ultrasound sensitivity was relatively high, specificity was somewhat lower. Adenomyosis often exhibits less distinct ultrasound features, thickened junctional zone or myometrial heterogeneity, which can sometimes overlap with other uterine pathologies or normal anatomical variations. This could explain the slight decrease in specificity, as some benign variations in the uterus might resemble adenomyosis, leading to potential false positives. Studies suggest that advanced imaging techniques like MRI may provide higher specificity for adenomyosis; however, these methods are more costly and less accessible, making ultrasound a practical first-line tool in most clinical settings^{17 18 19}.

The cases of combined pathology in this study revealed the lowest specificity, which highlights a diagnostic challenge. When adenomyosis and leiomyoma co-exist, their overlapping ultrasound features can make differential diagnosis more complex, leading to potential misinterpretations. This finding suggests that for patients presenting with atypical or inconclusive ultrasound results, supplementary imaging or clinical follow-up may be beneficial. The inclusion of histopathology as a diagnostic confirmation tool in this study enabled a clear understanding of the true pathology, supporting the role of histological analysis in refining the diagnosis for surgical cases.

Additionally, the demographic characteristics in our study offer valuable insight into the risk profile associated with adenomyosis and leiomyoma. Women in the study group had a higher prevalence of menstrual irregularities and family histories of uterine conditions compared to the control group, indicating potential hereditary or hormonal influences. These observations are consistent with existing literature that associates adenomyosis and leiomyoma with age, family history, and hormonal changes^{20 21}.

While ultrasound proved reliable overall, this study emphasizes the importance of a multi-modal diagnostic approach, particularly for complex cases. For patients undergoing surgery, histopathology remains the gold standard, especially where ultrasound findings are inconclusive or in cases where adenomyosis and leiomyoma overlap. This approach not only strengthens diagnostic accuracy but also guides appropriate treatment decisions, particularly in cases where fertility preservation or symptom management is the goal.

In conclusion, this study supports ultrasound as a valuable primary diagnostic tool for adenomyosis, leiomyoma, and combined pathology, given its high sensitivity and relatively robust specificity. However, in situations of combined pathology or ambiguous findings, additional diagnostic support through histopathology or advanced imaging can significantly improve diagnostic accuracy and inform optimal patient care.

Conclusion

Ultrasound has proven to be a valuable and reliable tool for the initial diagnosis of uterine conditions such as adenomyosis, leiomyoma, and cases where these pathologies coexist. This study's findings indicate that ultrasound offers high sensitivity and positive predictive value, especially in detecting leiomyoma, underscoring its suitability for routine clinical evaluation. However, for complex cases or where symptoms are atypical, combining ultrasound with histopathological analysis remains essential to achieve diagnostic clarity. The study highlights that while ultrasound serves effectively as a first-line diagnostic method, histopathology provides definitive confirmation, ensuring accurate diagnosis and aiding in tailored treatment planning. This integrated approach enhances patient outcomes, particularly when distinguishing between similar or overlapping uterine conditions

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