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DIAGNOSTIC ACCURACY OF SONOGRAPHY IN ADENOMYOSIS: A HISTOPATHOLOGICAL CORRELATION

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Abstract

Introduction: *In the evaluation of pelvic pain and menstrual disorders, transvaginal ultrasound remains the imaging modality of choice. However, accurate diagnosis of adenomyosis depends on the expertise of the sonographer in identifying its characteristic features. With ongoing advancements in sonographic technology, the detection of adenomyosis has become increasingly reliable, enabling clinicians to offer more precise and individualized treatment.*

Objective: *To evaluate the diagnostic performance of transvaginal sonography in identifying adenomyosis, with histopathological findings serving as the reference standard.*

Materials and Methods: *This cross-sectional validation study was conducted at the Diagnostic Radiology and Pathology Departments, Wah Medical College / POF Hospital, Wah Cantt, over a period from August 2018 to August 2019. A total of 101 female patients presenting with heavy menstrual bleeding were enrolled. All underwent surgical intervention, after which specimens were sent for histopathological examination. Histopathological findings, interpreted by a consultant pathologist, were compared with preoperative sonographic results.*

Results: *The participants had a mean age of 38.3 ± 5.5 years. In comparison to histopathology, transvaginal sonography demonstrated a sensitivity of 88.0%, specificity of 92.1%, positive predictive value of 78.5%, negative predictive value of 95.8%, and an overall diagnostic accuracy of 91.0%.*

Conclusion: *Sonography demonstrates high diagnostic accuracy in the detection of adenomyosis. Attention to both common and atypical sonographic features is crucial for improving diagnostic confidence and outcomes.*

INTRODUCTION

Adenomyosis is a gynecological condition characterized by the presence of ectopic, non-neoplastic endometrial glands and stroma within the myometrium, leading to smooth muscle hypertrophy and hyperplasia. The condition was initially noted in 1860 by the German pathologist Carl von Rokitansky, who described endometrial glands embedded in the myometrium and termed it

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"cystosarcoma adenoides uterinum." Later, in 1925, Frankl coined the term "adenomyosis uteri" to define the presence of endometrial tissue islands within the uterine muscle layer, distinct from inflammatory conditions. In 1972, Bird and colleagues offered a widely accepted definition of adenomyosis as a benign infiltration of the endometrium into the myometrium, resulting in a diffusely enlarged uterus with histological features of displaced endometrial glands and stroma encircled by thickened myometrial tissue.

The prevalence of adenomyosis in surgical series varies widely from 5% to 70%, averaging around 20–30%, with variation by geography and ethnicity [1]. In Pakistan reported prevalence ranges from 6.2% to 34.37% [2]. Adenomyosis primarily affects women of reproductive age and is associated with various risk factors, including multiparity, uterine trauma, endometriosis, hyperestrogenism, and increasing age[3]. The disease may present in either a focal (adenomyoma) or diffuse form, depending on whether ectopic endometrial tissue forms localized nodules or is scattered throughout the myometrium [4].

Although its precise cause remains uncertain, two major theories attempt to explain its pathogenesis: the invagination theory and the metaplasia theory. García-Solares et al. [1] discuss how the invagination theory proposes that the basalis layer of the endometrium invades the myometrium following injury, while the metaplasia theory suggests a transformation of Müllerian remnants or stem cells into endometrial tissue. The tissue injury and repair (TIAR) hypothesis, an extension of the invagination theory, was proposed by Leyendecker and colleagues, but current evidence remains insufficient to confirm or refute these mechanisms [1]. Additionally, Tosti et al. [5] have emphasized that different subtypes of adenomyosis may follow varied pathogenic pathways.

While many patients remain asymptomatic, others report pelvic pain, dysmenorrhoea, menometrorrhagia, or infertility. Adenomyosis often coexists with leiomyomas, endometriosis, or polyps, making symptom-based diagnosis unreliable [4].

The Morphological Uterus Sonographic Assessment (MUSA) group released a consensus in 2015 regarding myometrial lesion descriptions via ultrasound, which was later updated in 2021 by Van den Bosch et al. [6], who reclassified the sonographic features of adenomyosis into direct and indirect signs. This revision significantly enhanced the accuracy and consistency of non-invasive diagnosis [7].

Though histopathological confirmation via hysterectomy remains the gold standard, transvaginal ultrasound (TVUS) and MRI are now widely accepted diagnostic modalities. Tellum et al. [8] emphasized the value of TVUS for its cost-effectiveness, accessibility, and accuracy—reporting a sensitivity of 65–81% and specificity of 65–100%. MRI, while useful, is less readily available in resource-limited settings [9].

Although diagnostic techniques have improved, there is still a scarcity of research on adenomyosis within the Pakistani population. This study aims to assess the sonographic findings observed locally and determine the most indicative features of adenomyosis in our setting.

Study Objective

To evaluate the diagnostic performance of transvaginal sonography in identifying adenomyosis, with histopathological findings serving as the reference standard.

MATERIALS AND METHODS

This cross-sectional validation study was conducted at the Diagnostic Radiology and Pathology Departments, Wah Medical College / POF Hospital, Wah Cantt. The study was carried out over a one-year span, beginning on 5th August, 2018, and concluding on 4th August 2019. A sample size of 101 was calculated using the WHO sample size calculator, assuming a 30% prevalence of adenomyosis and a 95% confidence level using non-probability purposive sampling.

Inclusion and exclusion Criteria

The study included females aged 15–45 years presenting with clinical features suggestive of adenomyosis, such as excessive menstrual bleeding, persistent pelvic pain, dysmenorrhea, or an enlarged uterus. Patients were excluded if they were postmenopausal, pregnant, or diagnosed with malignancies. Additional exclusion criteria comprised pelvic organ prolapse, current hormone

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replacement therapy (HRT), contraindications to MRI (e.g., pacemakers, severe claustrophobia, or contrast hypersensitivity), and those deemed medically unfit for surgery. These criteria ensured a focused evaluation of adenomyosis while minimizing confounding factors.

Data Collection

Following approval from the institutional ethics committee, written informed consent was secured from all eligible participants. A structured questionnaire was used to gather demographic and clinical information. Pelvic ultrasound examinations were performed using a 3.5 MHz curvilinear transabdominal probe, followed by transvaginal scans with a 7.5 MHz probe after ensuring optimal bladder filling. All ultrasound interpretations were performed by a consultant radiologist. Ultrasound findings were assessed for features suggestive of adenomyosis, including myometrial cysts, an enlarged and globular uterus, heterogeneous myometrial echotexture, thickening or irregularity of the junctional zone, and hyperechoic linear striations. Following imaging, all patients underwent surgical intervention (hysterectomy), and the excised specimens were examined histopathologically by a consultant pathologist. The sonographic findings were then systematically compared with histopathology results to determine the diagnostic accuracy of ultrasound in detecting adenomyosis.

Data Analysis

Data analysis was performed using SPSS version 23. Descriptive statistics were used to summarize demographic details and ultrasound characteristics. Categorical variables were presented as frequencies and percentages. The diagnostic performance of ultrasonography was determined by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) through a 2×2 contingency table, using histopathological findings as the gold standard.

RESULTS

A total of 101 women of reproductive age were enrolled in the study, with a mean age of 38.3 ± 5.5 years. Among them, 10 patients (9.9%) were in the 20–30-year age group, while the majority—91 patients (90.1%)—were between 31 and 45 years of age. On transvaginal sonography, the most frequently observed feature was an enlarged, bulky uterus (99 patients, 98.0%). Asymmetrical myometrium was present in 51 patients (50.5%), followed by myometrial cysts in 45 patients (44.6%). Alterations in the junctional zone were noted in 25 patients (24.8%), and hyperechoic striations were observed in 21 patients (20.8%). Since multiple sonographic findings could coexist in a single patient, the total exceeds 100%. A summary is presented in **Table I**.

Table I: Sonographic findings in patients (n = 101)

Sonographic Feature	Number	Percentage (%)
Enlarged bulky uterus	99	98.0
Asymmetrical myometrium	51	50.5
Myometrial cysts	45	44.6
Junctional zone alteration	25	24.8
Hyperechoic striations	21	20.8

Note: Multiple findings were observed in several patients.

The diagnostic performance of sonography was assessed using histopathology as the gold standard. Sonography identified 22 true positive cases, 6 false positives, 3 false negatives, and 70 true negatives.

The calculated sensitivity was 88.0%, specificity 92.1%, PPV 78.5%, NPV 95.8%, and overall diagnostic accuracy was 91.0%. Detailed distribution is shown in **Table II**.

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Table II: Diagnostic performance of sonography vs. histopathology (n = 101)

	Histopathology Positive	Histopathology Negative	Total
Sonography Positive	22 (True Positive)	6 (False Positive)	28
Sonography Negative	3 (False Negative)	70 (True Negative)	73
Total	25	76	101

Diagnostic Values:

- **Sensitivity:** 22 / (22 + 3) × 100 = **88.0% (95% CI= 75.3% to 100.0%)**
- **Specificity:** 70 / (70 + 6) × 100 = **92.1% (95% CI= 86.0% to 98.2%)**
- **PPV:** 22 / (22 + 6) × 100 = **78.5%**
- **NPV:** 70 / (70 + 3) × 100 = **95.8%**
- **Diagnostic Accuracy:** (22 + 70) / 101 × 100 = **91.0%**

DISCUSSION

Transvaginal ultrasound (TVUS), a non-invasive imaging technique, is essential in the diagnosis of adenomyosis. In this study, TVUS showed a sensitivity of 88.0%, specificity of 92.1%, positive predictive value (PPV) of 78.5%, negative predictive value (NPV) of 95.8%, and an overall diagnostic accuracy of 91.0% when evaluated against histopathological findings. These findings compare favorably to Kepkep et al. [10], who reported lower rates (sensitivity 80.8%, specificity 61.4%, and diagnostic accuracy 68.6%. In a similar study, specificity remained low at 43.4% for adenomyosis [11]. Our higher specificity likely reflects the use of updated MUSA 2021 criteria and the high expertise of the radiologist, underscoring the importance of standardized protocols and operator skill in achieving accurate diagnosis.

Other studies support these findings. Eisenberg et al. [12] documented 100% sensitivity but only 25% specificity; however, only 15% of cases included histological confirmation. Cunningham et al. [13] reported balanced sensitivity and specificity (86% each), with heterogeneous myometrium being the most indicative feature. Despite this, TVUS can sometimes be confused with leiomyomas because of overlapping sonographic features. This distinction is clinically significant, as adenomyosis often leads to conservative management while fibroids may necessitate different interventions. Our study reinforces the value of recognizing features like myometrial cysts and striations, whose presence improved specificity.

Recent meta-analyses affirm the general performance of imaging: TVUS shows pooled sensitivity of ~82–84% and specificity of ~64% for 2D imaging [14]. A 2023 meta-analysis found comparable performance between TVUS and MRI, with no significant difference in diagnostic accuracy [15]. This is corroborated in our context, where MRI remains limited in Pakistan due to cost and availability, making ultrasound the preferred initial diagnostic tool.

Advanced ultrasound techniques such as 3D imaging, elastography, and Doppler have shown promise. Săsăran et al. [16] reported these as having high diagnostic value. Similarly, newer meta-analyses found no significant difference between TVUS and MRI for diagnosing adenomyosis [17]. A head-to-head meta-analysis by Alcázar et al. [18] reported **no significant difference** between TVUS and MRI (p = 0.7509), confirming equivalence in diagnostic performance. Rubab et al. [19] also compared the diagnostic performance of transvaginal ultrasound (TVUS) and MRI for the evaluation of adenomyosis, reporting comparable accuracy between the two imaging modalities. Additional recent work by Brunelli et al. [20] highlights the promise of elastography-enhanced ultrasound in detecting adenomyosis

We identified classic gray-scale features: asymmetric thickening, a globular uterus, heterogeneous myometrium, endometrial margin blurring, echogenic striations, and myometrial cysts—consistent with existing literature. Our study's strengths include a prospective design, histopathological confirmation for all patients, and

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application of a standardized sonographic protocol. Limitations include the single-center setting and operator dependence intrinsic to ultrasound. Future studies should explore advanced imaging and multi-operator reproducibility.

CONCLUSION

Our study supports transvaginal ultrasound (TVUS) as a robust first-line diagnostic tool for adenomyosis, demonstrating high diagnostic accuracy comparable to MRI when performed by trained specialists. Future directions should focus on standardizing imaging protocols to enhance consistency, incorporating advanced modalities such as 3D ultrasound, elastography, and contrast-enhanced techniques to improve sensitivity and specificity, and developing integrated diagnostic pathways that combine clinical assessment with imaging findings. Additionally, evaluating the role of artificial intelligence (AI)-assisted interpretation could help reduce inter-observer variability and enhance diagnostic reliability.

Authors' Contribution:

[1]Conception; Literature research
[1,2,4]Manuscript design and the acquisition, analysis, or interpretation of data for the work
[2,3,4]Critical analysis and manuscript review
[1,5,6]Data analysis; Manuscript Editing

Disclaimer

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Conflict of interest

The authors declare no conflict of interest.

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REFERENCES

García-Solares J, Donnez J, Donnez O, Dolmans MM. Pathogenesis of uterine adenomyosis: invagination or metaplasia? Fertil Steril. 2018;109(3):371–379.

Moin T, Malik A, Rafique M. Frequency of adenomyosis in hysterectomy specimens in women presenting with abnormal uterine bleeding. J Pak Med Assoc. 2020;70(1):123–127.

Dueholm M. Diagnostic criteria for adenomyosis. Best Pract Res Clin Obstet Gynaecol. 2021; 74:28–40.

Kobayashi H, Matsubara S, Yoshimoto C, et al. Pathogenesis and clinical manifestations of adenomyosis. Biomedicines. 2022;10(2):347.

Tosti C, Pinzauti S, Fagotti A, et al. Adenomyosis: a systematic review of pathogenesis, diagnosis, treatment, and association with infertility. Int J Mol Sci. 2021;22(23):11776.

Van den Bosch T, de Bruijn AM, Dueholm M, et al. Sonographic classification and reporting system for myometrial pathology: consensus from the Morphological Uterus Sonographic Assessment (MUSA) group. Ultrasound Obstet Gynecol. 2021;57(2):321–329.

Harmsen MJ, Van den Bosch T, de Leeuw RA, et al. Consensus on revised definitions of Morphological Uterus Sonographic Assessment (MUSA) features of adenomyosis: results of modified Delphi procedure. Ultrasound Obstet Gynecol. 2022 Jul;60(1):118-131. doi: 10.1002/uog.24786. PMID: 34587658; PMCID: PMC9328356.

Tellum T, Brar R, Abbott J. Ultrasound for diagnosis of adenomyosis: a review. Ultrasound Obstet Gynecol. 2021;57(5):573–582.

Exacoustos C, Malzoni M, Di Giovanni A, et al. Adenomyosis: what the patient needs. J Minim Invasive Gynecol. 2020;27(3):305–319.

Kepkep K, Tuncay YA, Göynümer G, Tutal E. Transvaginal sonography in the diagnosis of adenomyosis: which findings are most accurate? Ultrasound in Obstetrics and Gynecology: J Int Soc Ultrasound Obstet Gynecol. 2007; 30: 341-5.

Hanafi M. Ultrasound diagnosis of adenomyosis, leiomyoma, or combined with histopathological correlation. J Human Reprod Sci. 2013; 6:189-93.

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Eisenberg VH, Arbib N, Schiff E, Goldenberg M, Seidman DS, Soriano D. Sonographic signs of adenomyosis are prevalent in women undergoing surgery for endometriosis and may suggest a higher risk of infertility. BioMed research international. 2017 Oct; 2017: 1-9.

Cunningham RK, Horrow MM, Smith RJ, Springer J. Adenomyosis: a sonographic diagnosis. Radiographics. 2018; 38:1576-89.

Andres MP, Borrelli GM, Abrao MS, Kho RM, Viganò P, Carvalho FM. Transvaginal ultrasound for the diagnosis of adenomyosis: systematic review and meta-analysis. J Minim Invasive Gynecol. 2018;25(2):257–64. doi:10.1016/j.jmig.2017.08.653.

Guerriero S, Marra C, Moruzzi MC, Ajossa S, Pascual MA, Savelli L, et al. Diagnostic accuracy of transvaginal ultrasound and magnetic resonance imaging for adenomyosis: A systematic review and meta-analysis. J Minim Invasive Gynecol. 2023;30(1):12–25. doi:10.1016/j.jmig.2022.05.013.

Săsăran V, Mărginean C, Puşcaşiu L. Current Non-Invasive Imaging Techniques Used in the Diagnosis of Adenomyosis. Clin. Exp. Obstet. Gynecol. 2023; 50(3): 49 https://doi.org/10.31083/j.ceog5003049

Liu L, Li W, Leonardi M, Condous G, Da Silva Costa F, Mol BW, Wong L. Diagnostic Accuracy of Transvaginal Ultrasound and Magnetic Resonance Imaging for Adenomyosis: Systematic Review and Meta-Analysis and Review of Sonographic Diagnostic Criteria. J Ultrasound Med. 2021 Nov; 40(11):2289-2306. doi: 10.1002/jum.15635.

Alcázar JL, Vara J, Usandizaga C, Ajossa S, Pascual MÁ, Guerriero S. Transvaginal ultrasound versus magnetic resonance imaging for diagnosing adenomyosis: A systematic review and head-to-head meta-analysis. Int J Gynaecol Obstet. 2023 May; 161(2):397-405. doi: 10.1002/ijgo.14609.

Rubab S, Maqsood A, Rafique MS, Kundi S, Yasin A, Tariq T. Comparing Accuracies of Transvaginal Ultrasonography and Magnetic Resonance Imaging for Nonsurgical Diagnosis of Adenomyosis. J Soc Obstet Gynaecol Pak. 2022; 12(3):225-229

Brunelli AC, Brito LGO, Moro FAS, Jales RM, Yela DA, Benetti-Pinto CL. Ultrasound Elastography for the Diagnosis of Endometriosis and Adenomyosis: A Systematic Review with Meta-analysis. Ultrasound Med Biol. 2023 Mar;49(3):699-709. doi: 10.1016/j.ultrasmedbio.2022.11.006. Epub 2022 Dec 15. PMID: 36528440.