

Diagnostic Value of Individual Transvaginal Ultrasound Criteria for Adenomyosis and Leiomyoma

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DOI: <https://doi.org/10.36348/sijog.2026.v09i08.005>

| Received: 28.06.2026 | Accepted: 22.08.2026 | Published: 29.08.2026

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Abstract

Background: Adenomyosis and leiomyoma are common benign uterine disorders with overlapping clinical and imaging features, making accurate preoperative diagnosis challenging. This study evaluated the diagnostic value of individual transvaginal ultrasonography (TVS) criteria for adenomyosis and leiomyoma using histopathology as the reference standard. **Methods:** This analytical cross-sectional study was conducted among 150 women aged 30–55 years with TVS-diagnosed adenomyosis, leiomyoma, or both who subsequently underwent hysterectomy, myomectomy, or adenomyomectomy and had histopathological confirmation. Participants were enrolled using purposive sampling. Individual TVS criteria for adenomyosis and leiomyoma were compared with corresponding histopathological findings. Statistical analyses were performed using SPSS version 26.0, with $p < 0.05$ considered statistically significant. **Results:** Leiomyoma was the most common diagnosis (61.33%), followed by combined adenomyosis and leiomyoma (26.00%) and adenomyosis alone (12.67%). For adenomyosis, no distinction of the endometrial-myometrial junction (78.9%), asymmetry of the anterior and posterior myometrium (83.3%), heterogeneous myometrial echotexture (80.3%) and myometrial cysts with fibrosis (62.5%) showed significant associations with histopathology (all $p < 0.0001$). For leiomyoma, clear tumor margin demarcation (96.7%), peripheral vascularity on color Doppler (95.6%), irregular uterine surface (93.5%) and irregular endometrial surface (95.7%) were also significantly associated with histopathological confirmation ($p \leq 0.005$). **Conclusion:** Individual TVS criteria demonstrated significant diagnostic value for adenomyosis and leiomyoma. Recognition of these sonographic features may improve preoperative diagnostic accuracy and support appropriate clinical management.

Keywords: Adenomyosis; Leiomyoma; Transvaginal ultrasonography; Histopathology; Diagnostic accuracy.

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INTRODUCTION

Adenomyosis and leiomyoma are among the most common benign uterine disorders affecting women of reproductive age and are important causes of abnormal uterine bleeding, dysmenorrhea, chronic pelvic pain, infertility and reduced quality of life [1]. These conditions frequently coexist, making accurate preoperative diagnosis challenging because of overlapping clinical manifestations and imaging findings [2]. Precise differentiation between adenomyosis and leiomyoma is essential for selecting appropriate treatment, planning surgical interventions and

counseling patients regarding fertility preservation and long-term management [3].

Histopathological examination remains the gold standard for confirming the diagnosis of adenomyosis and leiomyoma [4]. However, histopathological confirmation is only possible after surgical removal of uterine tissue, limiting its role in preoperative decision-making [5]. Therefore, reliable noninvasive imaging techniques are essential for the accurate evaluation of women presenting with suspected uterine pathology [6].

Citation: Akter, K., Khatun, F., Urmi, R. H., Kauser, U. S., & Alam, S. (2026). Diagnostic Value of Individual Transvaginal Ultrasound Criteria for Adenomyosis and Leiomyoma. *Sch Int J Obstet Gynec*, 9(8), 176-181. <https://doi.org/10.36348/sijog.2026.v09i08.005>

Transvaginal ultrasonography (TVS) is widely accepted as the first-line imaging modality for the assessment of uterine abnormalities because it is readily available, cost-effective, noninvasive and capable of providing high-resolution visualization of the uterus and adnexa [7]. Advances in ultrasound technology, including high-frequency transvaginal probes and color Doppler imaging, have improved the detection of characteristic sonographic features associated with adenomyosis and leiomyoma [8]. In clinical practice, TVS plays a pivotal role in distinguishing between these conditions and guiding subsequent management [9].

Several individual sonographic criteria have been described for the diagnosis of adenomyosis, including loss of the endometrial-myometrial junction, asymmetry of the anterior and posterior myometrium, subendometrial myometrial striations, myometrial cysts with fibrosis and heterogeneous myometrial echotexture [10]. Similarly, characteristic ultrasound features of leiomyoma include clear tumor margin demarcation, a whorled appearance of the lesion, peripheral vascularity on color Doppler, irregularities of the uterine surface and distortion of the endometrial surface in submucosal tumors [11]. Although combinations of these features are commonly used to establish a diagnosis, the diagnostic contribution of each individual criterion has not been fully elucidated [12].

The present study was undertaken to evaluate the diagnostic value of individual transvaginal ultrasound criteria for adenomyosis and leiomyoma by comparing each sonographic feature with the corresponding histopathological diagnosis, thereby identifying the ultrasound findings that provide the greatest diagnostic utility in clinical practice.

METHODOLOGY & MATERIALS

This analytical cross-sectional study was conducted in the Department of Obstetrics and Gynecology, Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) General Hospital, Dhaka, from January 2023 to June 2024. A total of 150 women aged 30–55 years with transvaginal ultrasonography (TVS)-diagnosed adenomyosis, leiomyoma, or both who subsequently underwent hysterectomy, myomectomy, or adenomyomectomy and had available histopathological

reports were enrolled using purposive sampling. Postmenopausal women, patients with a uterus larger than 16 weeks' size, uterine malignancy, endometriosis, or pelvic inflammatory disease were excluded. Data on sociodemographic characteristics, symptoms, menstrual and obstetric history, TVS findings and histopathological results were collected using a pretested semi-structured questionnaire. TVS examinations were performed before surgery using a LOGIQ 9 ultrasound system (GE Healthcare, Milwaukee, WI, USA) equipped with a 7–9 MHz endovaginal probe, with color Doppler evaluation. All examinations were interpreted by the same investigator with 5 years of experience in female pelvic sonography to minimize interobserver variation. The assessed sonographic criteria for adenomyosis included no distinction of the endometrial-myometrial junction, asymmetry of the anterior and posterior myometrium, subendometrial myometrial striations, myometrial cysts and fibrosis and heterogeneous myometrial echotexture, while those for leiomyoma included clear tumor margin demarcation, whorly tumor appearance, peripheral vascularity on color Doppler, irregular uterine surface and irregular endometrial surface. Histopathological examination of the surgical specimens served as the reference standard. Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation and categorical variables as frequency and percentage. Chi-square test, Fisher's exact test and ANOVA were applied as appropriate, with a p-value <0.05 considered statistically significant. Ethical approval was obtained from the Institutional Review Board of BIRDEM and written informed consent was obtained from all participants before enrollment.

RESULTS

This analytical cross-sectional study was conducted to diagnose of adenomyosis, leiomyoma, or combined adenomyosis and leiomyoma by the use of transvaginal ultrasonography (TVS) which was compared with histopathological findings. A total of 150 women who underwent hysterectomy or myomectomy or adenomyomectomy due to leiomyoma, adenomyosis or combined in the inpatient department of Obstetrics and Gynecology, BIRDEM General Hospital were enrolled for the study. The results, including tables, are presented within this chapter.

Table I: Categorization of the respondents according to sociodemographic characteristic by groups

Sociodemographic characteristic	Adenomyosis (n=19)	Leiomyoma (n=92)	Combination of Adenomyosis and Leiomyoma (n=39)	P value
Age				
Mean $\pm$ SD	42.7 $\pm$ 2.3	41.3 $\pm$ 3.6	45.2 $\pm$ 2.0	0.523 ^c
Educational qualification				
Class I-V	7 (36.8)	42 (45.6)	18 (46.2)	0.177*
Class VI-X	5 (26.3)	30 (32.6)	14 (35.9)	
Class XI-XII	5 (26.3)	16 (17.3)	3 (7.7)	
Graduate	2 (10.5)	4 (4.3)	2 (10.3)	

Sociodemographic characteristic	Adenomyosis (n=19)	Leiomyoma (n=92)	Combination of Adenomyosis and Leiomyoma (n=39)	P value
Occupation				
Housewife	18 (94.7)	76 (42.6)	33 (84.6)	0.042*
Working woman	1 (5.3)	15 (16.3)	6 (15.4)	
Monthly income				
Mean $\pm$ SD	40473.7 $\pm$ 5368.3	45695.7 $\pm$ 5395.8	38230.7 $\pm$ 7001.7	0.074 ^c
BMI (Mean $\pm$ SD)	23.7 $\pm$ 1.3	26.3 $\pm$ 1.3	25.8 $\pm$ 1.3	0.774 ^c

^cANOVA test, * Fisher's Exact test

Table I shows that the mean age was similar across groups (adenomyosis: 42.7 $\pm$ 2.3 years, leiomyoma: 41.3 $\pm$ 3.6 years, combination: 45.2 $\pm$ 2.0 years; p = 0.523). In terms of education, most had a Class I-V education (adenomyosis: 36.8%, leiomyoma: 45.6%, combination: 46.2%; p = 0.177). The majority were housewives (adenomyosis: 94.7%, leiomyoma: 42.6%,

combination: 84.6%; p = 0.042). The mean monthly income varied slightly (adenomyosis: 40,473.7 $\pm$ 5,368.3, leiomyoma: 45,695.7 $\pm$ 5,395.8, combination: 38,230.7 $\pm$ 7,001.7; p = 0.074). BMI averages are similar across groups, approximately 23.7 $\pm$ 1.3 for Adenomyosis, 26.3 $\pm$ 1.3 for Leiomyoma and 25.8 $\pm$ 1.3 for the combination group (p =0.774).

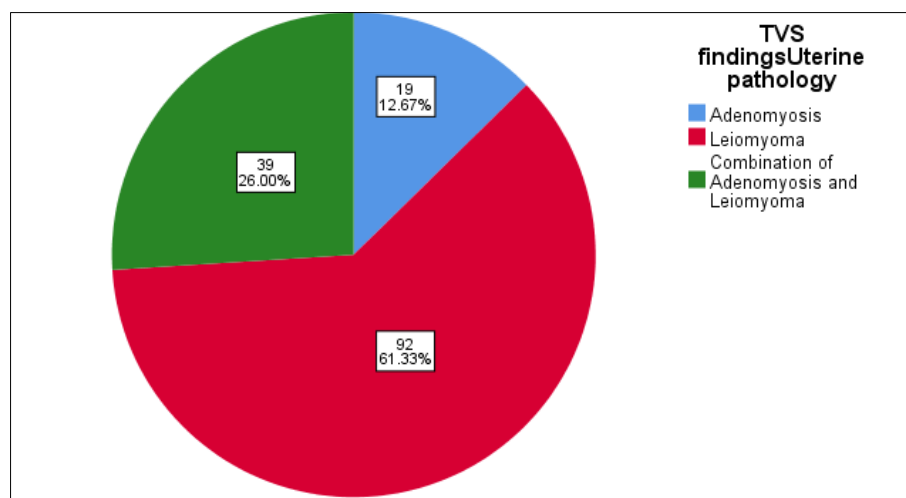


Figure 1: TVS findings of uterine pathology

Figure 1 illustrates that among the respondents, the majority (61.33%) had leiomyoma, followed by

26.00% with both adenomyosis and leiomyoma and 12.67% had adenomyosis.

Table II: Comparison of Various Diagnostic Criteria of Transvaginal Ultrasound (TVS) Findings with Histopathology for Diagnosis of Adenomyosis

TVS (Adenomyosis)	Histopathology (Adenomyosis)		P value
	Yes	No	
No distinction of the endometrial-myometrial junction			
Yes	30 (78.9)	2 (1.7)	<0.0001*
No	8 (21.0)	110 (98.2)	
Asymmetry of the anterior and posterior myometrium			
Yes	50 (83.3)	3 (3.3)	<0.0001 ^a
No	10 (16.6)	87 (96.6)	
Myometrial cysts and fibrosis			
Yes	10 (62.5)	1 (1.0)	<0.0001*
No	6 (37.5)	133 (99.0)	
Heterogeneous myometrial echotexture			
Yes	53 (80.3)	5 (5.9)	<0.0001*
No	13 (19.6)	79 (94.0)	

^aChi square test, * Fisher's Exact test

Table II illustrates significant correlations between various Transvaginal Ultrasound (TVS) findings for adenomyosis and their confirmation by histopathology. TVS identified 78.9% of cases with no distinction of the endometrial-myometrial junction, confirmed by histopathology ($p < 0.0001$). Regarding asymmetry of the anterior and posterior myometrium,

83.3% identified by TVS were confirmed by histopathology ($p < 0.0001$). TVS identified myometrial cysts and fibrosis in 62.5% of cases confirmed by histopathology ($p < 0.0001$). For heterogeneous myometrial echotexture, 80.3% identified by TVS were confirmed by histopathology ($p < 0.0001$).

Table III: Comparison of Various Diagnostic Criteria of Transvaginal Ultrasound (TVS) Findings with Histopathology for Diagnosis of Leiomyoma

TVS (Leiomyoma)	Histopathology (Leiomyoma)		P value
	Yes	No	
Clear demarcation of the tumor margin			
Yes	120 (96.7)	11 (42.3)	<0.0001*
No	4 (3.2)	15 (57.6)	
The presence of blood vessels (by color Doppler) surrounding the tumor			
Yes	88 (95.6)	02 (3.4)	0.004 ^a
No	4 (4.3)	56 (96.5)	
Irregularities of the uterine surface (subserous and intramural tumors)			
Yes	58 (93.5)	8 (9.0)	0.005 ^a
No	4 (6.4)	80 (90.9)	
Irregularities of the endometrial surface (submucous tumors type 1 and 2)			
Yes	67 (95.7)	2 (2.5)	0.004 ^a
No	3 (4.2)	78 (97.5)	

^aChi square test, * Fisher's Exact test

Table III shows the comparison of transvaginal ultrasound (TVS) findings with histopathology for diagnosing leiomyoma showed that clear tumor margin demarcation on TVS was highly correlated (96.7%) with histopathological confirmation ($p < 0.0001$). TVS identified 95.6% of cases of leiomyoma with presence of surrounding blood vessels on color Doppler, confirmed by histopathology ($p = 0.004$). The irregularities of the uterine surface and irregularities of the endometrial surface in TVS were significantly associated with histopathological confirmation of leiomyoma (93.5% and 95.7%, $p = 0.005$ and $p = 0.004$ respectively).

DISCUSSION

The present study evaluated the diagnostic value of individual transvaginal ultrasonography (TVS) criteria for adenomyosis and leiomyoma using histopathology as the reference standard. TVS demonstrated significant associations between individual sonographic features and histopathological diagnosis for both conditions. Among adenomyosis cases, no distinction of the endometrial-myometrial junction (78.9%), asymmetry of the anterior and posterior myometrium (83.3%), myometrial cysts and fibrosis (62.5%) and heterogeneous myometrial echotexture (80.3%) were all significantly associated with histopathological confirmation (all $p < 0.0001$). For leiomyoma, clear tumor margin demarcation (96.7%), peripheral vascularity on color Doppler (95.6%), irregular uterine surface (93.5%) and irregular endometrial surface (95.7%) also demonstrated significant correlations with histopathology.

The distribution of uterine pathology in the present study showed that leiomyoma was the most frequent diagnosis (61.33%), followed by the coexistence of adenomyosis and leiomyoma (26.00%), while isolated adenomyosis accounted for 12.67% of cases. Similar observations have been reported by Lonky *et al.*, who demonstrated that adenomyosis frequently coexists with uterine leiomyomas in women undergoing hysterectomy, emphasizing the importance of careful preoperative imaging to identify both pathologies simultaneously [13]. Likewise, Moawad *et al.*, and Moldassarina described the considerable overlap between adenomyosis and leiomyoma and highlighted the need for standardized ultrasound criteria to improve diagnostic precision [14,15].

The present study demonstrated that loss of the endometrial-myometrial junction and asymmetry of the myometrium were among the strongest sonographic indicators of adenomyosis. These findings are consistent with those reported by Farooqui *et al.*, who found that disruption of the junctional zone and asymmetrical myometrial thickening were highly predictive of histopathologically confirmed adenomyosis [16]. Similarly, Sayer Dayer *et al.*, reported that characteristic TVS findings showed a strong association with histopathological diagnosis, supporting the value of ultrasound as a reliable preoperative diagnostic tool [17]. Furthermore, Yavuz *et al.*, demonstrated that Morphological Uterus Sonographic Assessment (MUSA) features, particularly junctional zone

abnormalities and myometrial asymmetry, significantly improved the prediction of adenomyosis [18].

Heterogeneous myometrial echotexture was identified in 80.3% of histopathologically confirmed adenomyosis cases in the current study, while myometrial cysts and fibrosis were observed in 62.5%. Comparable findings have been described by Harmsen *et al.*, who reported good agreement between transvaginal ultrasound, MRI and histopathology for evaluating junctional zone abnormalities and heterogeneous myometrium [19]. Ren *et al.*, also emphasized that heterogeneous myometrial echotexture and myometrial cysts are valuable sonographic markers reflecting disease severity and are useful for monitoring treatment response [20].

For leiomyoma, clear tumor margin demarcation demonstrated the highest correlation with histopathology (96.7%), followed closely by peripheral vascularity on color Doppler (95.6%). These findings are in agreement with Abou Elela *et al.*, who concluded that pelvic ultrasonography effectively identifies uterine myomas through characteristic well-defined margins and vascular patterns [21]. Likewise, Zhang *et al.*, reported that vascular characteristics and lesion morphology are important sonographic features for differentiating leiomyomas from focal adenomyosis [22]. Kaya Narçiçeği *et al.*, further demonstrated that combining conventional ultrasound features with tissue elasticity assessment improves discrimination between adenomyosis and leiomyoma [23].

Recent advances in ultrasound technology have further strengthened the diagnostic capability of TVS. Zanolli *et al.*, reported high diagnostic accuracy of clinically interpreted pelvic ultrasound compared with surgical pathology for adenomyosis [24]. Similarly, Raimondo *et al.*, demonstrated that deep learning models applied to ultrasound images further improve the identification of adenomyosis by recognizing subtle sonographic features [25]. These developments support the growing role of ultrasound as an accurate, accessible and noninvasive diagnostic modality.

Limitations of the study

This study was conducted at a single tertiary care center using purposive sampling, which may limit the generalizability of the findings. In addition, only women who underwent surgical management with available histopathological reports were included, potentially introducing selection bias. Interobserver variability could not be assessed because all transvaginal ultrasound examinations were interpreted by a single experienced investigator.

CONCLUSION

Individual transvaginal ultrasound criteria showed significant diagnostic value for identifying adenomyosis and leiomyoma when compared with

histopathological findings. Features such as loss of the endometrial-myometrial junction, myometrial asymmetry, heterogeneous myometrial echotexture, clear tumor margin demarcation, peripheral vascularity and surface irregularities were strongly associated with histopathological diagnosis. Careful evaluation of these individual sonographic features can improve preoperative diagnostic accuracy and support appropriate clinical management.

Financial Support and Sponsorship: No funding sources.

Conflicts of Interest: There are no conflicts of interest.

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