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Original Research Article

Myometrial disease extent on standardized morphological uterus sonographic assessment transvaginal ultrasound is associated with severe dysmenorrhea in women with adenomyosis: a prospective observational study

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ABSTRACT

Background: Aim was to evaluate associations between standardized morphological uterus sonographic assessment (MUSA) transvaginal ultrasound features and dysmenorrhea severity in women with adenomyosis.
Methods: This prospective observational study included 42 consecutive premenopausal women with secondary dysmenorrhea and sonographically diagnosed adenomyosis between March 2025 and March 2026. Standardized transvaginal ultrasound was performed using a GE Voluson E8 system with an 8-MHz transvaginal transducer. MUSA features, disease type, and myometrial disease extent were recorded. Dysmenorrhea was assessed using a 0-10 numerical rating scale. Group comparisons and diagnostic performance measures were evaluated.
Results: Participants had mild (n=16), moderate (n=10), or severe (n=16) dysmenorrhea. Heavy menstrual bleeding, dyspareunia, chronic pelvic pain, several direct MUSA features, and the presence of at least two direct MUSA features increased across symptom groups. Myometrial involvement >50% occurred in 56.3% of women with severe dysmenorrhea versus 6.3% with mild symptoms. For severe dysmenorrhea, disease extent >50% had 56.3% sensitivity, 88.5% specificity, 75.0% positive predictive value, 76.7% negative predictive value, and 76.2% accuracy.
Conclusions: Greater myometrial disease extent was strongly associated with dysmenorrhea severity in this cohort. Standardized reporting of disease extent may add clinically useful information to MUSA-based ultrasound assessment, but larger patient-level studies are required to determine independent predictive value.

Keywords: Adenomyosis, Dysmenorrhea, Transvaginal ultrasound, MUSA, Pelvic pain, Disease extent

INTRODUCTION

Adenomyosis is a benign uterine disorder characterized by ectopic endometrial glands and stroma within the myometrium with surrounding smooth-muscle hypertrophy and hyperplasia. It is associated with dysmenorrhea, heavy menstrual bleeding, chronic pelvic pain, dyspareunia, infertility, and impaired quality of life.[4] Contemporary reviews emphasize its heterogeneous clinical presentation and the need for clinically useful phenotyping.[9]

Advances in imaging have shifted diagnosis away from reliance on hysterectomy specimens. Transvaginal ultrasound (TVUS) is widely used as a first-line modality, with magnetic resonance imaging serving as a complementary technique in selected cases.[1] Standardized sonographic terminology is important for reproducible diagnosis and reporting.[11]

The MUSA framework standardizes description of adenomyosis-related sonographic findings, including direct and indirect signs and characterization of disease distribution.[11] More recent work applying revised MUSA definitions has examined the diagnostic contribution of individual features.[12]

The clinical phenotype may vary according to lesion distribution and myometrial compartment involvement.[3] Studies correlating ultrasound features with symptoms suggest that imaging phenotype may contain information beyond the binary presence or absence of adenomyosis.[2]

The relationship between standardized sonographic disease burden and dysmenorrhea severity remains incompletely defined. Sonographic severity grading has been proposed, but its clinical interpretation requires further validation.[10]

METHODS

Study design and setting

This prospective observational study was conducted at the Department of Obstetrics and Gynecology, Faculty of Medicine, Zagazig University Hospitals, Zagazig, Egypt, between March 2025 and March 2026. The study evaluated associations between standardized TVUS features of adenomyosis and secondary dysmenorrhea severity.

Study population

Forty-two consecutive premenopausal women with clinically suspected adenomyosis and secondary dysmenorrhea were prospectively recruited from the gynecology outpatient clinic. Adenomyosis was diagnosed by TVUS using MUSA-based sonographic criteria.

Eligibility criteria

Women were eligible if they were 18-50 years old, premenopausal, had secondary dysmenorrhea, had a sonographic diagnosis of adenomyosis according to MUSA-based criteria, and agreed to participate. Women were excluded for pregnancy, menopause, previous hysterectomy, congenital uterine anomalies, pelvic inflammatory disease, gynecological malignancy, inadequate ultrasound visualization, or refusal to participate.

Clinical assessment

Clinical assessment included age, body mass index (BMI), gravidity, parity, menstrual history, heavy menstrual bleeding, chronic pelvic pain, and dyspareunia. Dysmenorrhea severity was assessed using a 0-10 numerical rating scale (NRS), in which 0 represented no pain and 10 the worst imaginable pain. Participants were categorized as having mild, moderate, or severe dysmenorrhea according to the study dataset.

Ultrasound examination

All examinations were performed using a GE Voluson E8 ultrasound machine equipped with an 8-MHz transvaginal transducer. Scans followed standardized MUSA-based assessment. Direct features assessed were myometrial cysts, hyperechogenic islands, echogenic subendometrial lines, and echogenic buds. Indirect features assessed were a globular uterus, asymmetrical myometrial thickening, fan-shaped shadowing, translesional vascularity, and irregular or interrupted junctional zone.

Disease classification

Adenomyosis was characterized by location (anterior, posterior, fundal, right lateral, left lateral, or diffuse), type (focal, diffuse, or mixed), and estimated myometrial disease extent (<25%, 25-50%, or >50%).

Outcome measures

The primary outcome was the association between ultrasound disease characteristics and severe dysmenorrhea. Secondary outcomes were associations between individual MUSA features and dysmenorrhea severity and the diagnostic performance of selected ultrasound characteristics for severe dysmenorrhea.

Statistical analysis

Continuous variables are presented as mean±standard deviation and categorical variables as number (percentage). One-way analysis of variance was used for the summarized continuous group data. Pearson chi-square tests were used to reassess categorical group comparisons from the available contingency tables. Diagnostic performance was calculated by classifying severe dysmenorrhea as the positive outcome and combining mild and moderate dysmenorrhea as the non-severe comparison group. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated directly from the reported cell counts. A two-sided $p<0.05$ was considered statistically significant. Because patient-level data and the original multivariable regression output were not available for this revision, multivariable regression and claims of independent prediction were not retained.

Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki, and written informed consent was obtained from all participants before enrollment. No institutional ethics approval number was available in the records provided for this revision; this information should be confirmed with the responsible institution before resubmission.

RESULTS

Study population and baseline characteristics

Forty-two women with sonographically confirmed adenomyosis were included: 16 with mild, 10 with moderate, and 16 with severe dysmenorrhea. Baseline age, BMI, gravidity, and parity did not differ significantly among the groups (Table 1).

Clinical characteristics

Heavy menstrual bleeding, dyspareunia, and chronic pelvic pain increased across dysmenorrhea severity groups. Recalculation from the available contingency tables showed statistically significant group differences for heavy menstrual bleeding (P=0.002), dyspareunia (P=0.042), and chronic pelvic pain (p=0.042) (Table 2).

Direct MUSA ultrasound features

Myometrial cysts (p=0.012), hyperechogenic islands (p=0.016), echogenic subendometrial lines (P=0.009), and the presence of at least two direct MUSA features (p=0.017) differed significantly among symptom groups. Echogenic buds did not reach statistical significance (p=0.177) (Table 3).

Disease characteristics

Diffuse adenomyosis increased from 12.5% in the mild group to 50.0% in the severe group, but this comparison did not reach statistical significance after recalculation (p=0.070). In contrast, disease extent >50% was present in 1/16 (6.3%) women with mild, 2/10 (20.0%) with moderate, and 9/16 (56.3%) with severe dysmenorrhea (p=0.006) (Table 4).

Diagnostic performance

For severe dysmenorrhea, myometrial disease extent >50% had sensitivity 56.3%, specificity 88.5%, PPV 75.0%, NPV 76.7%, and accuracy 76.2%. The presence of at least two direct MUSA features had sensitivity 93.8%, specificity 38.5%, PPV 48.4%, NPV 90.9%, and accuracy 59.5% (Table 5).

Table 1: Baseline demographic and reproductive characteristics according to dysmenorrhea severity.

Variables	Mild, (n=16)	Moderate, (n=10)	Severe, (n=16)	P value
Age (years), mean±SD	39.1±6.8	41.2±5.9	42.1±5.7	0.386
BMI (kg/m²), mean±SD	24.2±3.1	25.1±2.8	25.2±2.7	0.579
Gravidity, mean±SD	2.4±2.3	3.2±1.9	3.3±1.8	0.414
Parity, mean±SD	1.3±1.5	1.7±1.3	1.9±1.2	0.449

Table 2: Clinical characteristics according to dysmenorrhea severity.

Variables	Mild	Moderate	Severe	P value
Heavy menstrual bleeding	3 (18.8%)	6 (60.0%)	13 (81.3%)	0.002
Dyspareunia	4 (25.0%)	4 (40.0%)	11 (68.8%)	0.042
Chronic pelvic pain	3 (18.8%)	4 (40.0%)	10 (62.5%)	0.042

Table 3: Direct MUSA ultrasound features according to dysmenorrhea severity.

Features	Mild	Moderate	Severe	P value
Myometrial cysts	6 (37.5%)	7 (70.0%)	14 (87.5%)	0.012
Hyperechogenic islands	5 (31.3%)	6 (60.0%)	13 (81.3%)	0.016
Echogenic subendometrial lines	7 (43.8%)	7 (70.0%)	15 (93.8%)	0.009
Echogenic buds	4 (25.0%)	5 (50.0%)	9 (56.3%)	0.177
≥2 direct MUSA features	8 (50.0%)	8 (80.0%)	15 (93.8%)	0.017

Table 4: Disease characteristics according to dysmenorrhea severity.

Variables	Mild	Moderate	Severe	P value
Diffuse adenomyosis	2 (12.5%)	4 (40.0%)	8 (50.0%)	0.070
Disease extent >50%	1 (6.3%)	2 (20.0%)	9 (56.3%)	0.006

Table 5: Diagnostic performance of selected ultrasound parameters for severe dysmenorrhea.

Parameters	Sensitivity	Specificity	PPV	NPV	Accuracy
Disease extent >50%	56.3%	88.5%	75.0%	76.7%	76.2%
≥2 direct MUSA features	93.8%	38.5%	48.4%	90.9%	59.5%

DISCUSSION

This interpretation is consistent with reports that different adenomyosis phenotypes and myometrial compartments are associated with different clinical profiles.[3] Reviews of imaging-based classification similarly emphasize that phenotype and extent may be relevant to clinical outcomes, although standardized outcome-linked classifications remain incompletely validated.[9]

Several direct MUSA features also increased with dysmenorrhea severity. Myometrial cysts, hyperechogenic islands, echogenic subendometrial lines, and accumulation of at least two direct signs were more frequent in women with more severe symptoms. Biasioli et al. reported correlations between ultrasound criteria and symptoms, supporting the broader premise that sonographic morphology may reflect clinical expression of adenomyosis.[2] Studies applying revised MUSA definitions have also highlighted variation in the diagnostic contribution of individual signs.[12]

The association between greater disease burden and pain is biologically plausible. Adenomyosis is characterized by altered myometrial architecture, inflammatory signaling, and mechanisms relevant to nociception and tissue remodeling.[5] Shared pathophysiological mechanisms between endometriosis and adenomyosis may contribute to pelvic pain and dysmenorrhea.[6] Dysmenorrhea is a multidimensional symptom, and standardized pain scoring provides a pragmatic method for quantifying severity in clinical research.[13]

These observations should not be interpreted as establishing an independent prognostic cutoff. Sonographic severity grading is still evolving; a recent pilot study specifically addressed feasibility and interobserver reliability of grading adenomyosis severity.[10]

Systematic MUSA-based reporting may improve communication between imaging specialists and treating clinicians.[11] If confirmed in larger cohorts, documenting disease extent alongside individual MUSA signs could contribute to counseling and treatment planning. Current management remains individualized according to symptoms, reproductive goals, and disease context.[7] A range of current and prospective therapies has been described, underscoring the value of better clinical phenotyping.[8]

Strengths and limitations

Strengths include the prospective design, consecutive recruitment, standardized MUSA-based ultrasound assessment, and evaluation of clinically relevant symptom groups. Limitations include the small single-center sample, absence of MRI or histopathological confirmation, lack of longitudinal follow-up, and absence of patient-level data and original regression output for the present revision. Consequently, multivariable modeling could not be independently reproduced and the revised manuscript does not claim that disease extent is an independent predictor. The available summary data also do not permit reassessment of every originally reported ultrasound parameter.

Clinical implications

Routine documentation of myometrial disease extent may provide useful contextual information when evaluating women with adenomyosis and dysmenorrhea. The observed association is hypothesis-generating and should be externally validated using larger datasets with prespecified severity definitions, patient-level covariates, reproducibility assessment, and multivariable modeling.

CONCLUSION

In this prospective observational cohort, greater myometrial involvement on standardized MUSA-based TVUS was strongly associated with dysmenorrhea severity. Myometrial disease extent >50% was substantially more frequent in women with severe symptoms and showed relatively high specificity for severe dysmenorrhea, while multiple direct MUSA features showed high sensitivity but limited specificity. Disease extent may therefore be a useful component of standardized ultrasound reporting. Larger multicenter studies with patient-level multivariable analysis are required before an independent predictive role or clinically definitive cutoff can be established.

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