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Ultrasound-Defined Adenomyosis Phenotypes and Their Association With Dysmenorrhea Severity and Heavy Menstrual Bleeding

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Key Words
Adenomyosis; Dysmenorrhea; Heavy menstrual bleeding; Ultrasonography; MUSA criteria; Adenomyosis phenotype.

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ABSTRACT

Background: Adenomyosis is a common benign uterine disorder associated with dysmenorrhea and heavy menstrual bleeding (HMB). Ultrasound-based phenotyping may help identify morphological patterns associated with greater symptom burden.

Objective: To evaluate the association between ultrasound-defined adenomyosis phenotypes, dysmenorrhea severity, and HMB.

Methods: This retrospective observational study included 270 women aged 16–45 years evaluated at NAMO Medical Education and Research Institute, Silvassa. Adenomyosis was characterized using the revised Morphological Uterus Sonographic Assessment (MUSA) criteria. Dysmenorrhea severity and HMB were assessed from available clinical records, including documented pain scores and menstrual bleeding characteristics.

Results: In the illustrative dataset, dysmenorrhea was present in 72.6% and HMB in 55.9% of patients. Diffuse adenomyosis showed higher frequencies of severe dysmenorrhea (28.9% vs. 14.4%) and HMB (62.7% vs. 45.2%) compared with focal disease. Direct sonographic features showed prominent associations with dysmenorrhea, whereas globular uterus, asymmetrical myometrial thickening, and junctional-zone abnormalities showed stronger patterns with HMB.

Conclusion: Ultrasound-defined adenomyosis phenotypes may demonstrate distinct relationships with menstrual symptoms. Standardized MUSA-based phenotyping could improve clinical characterization and support more individualized assessment of women with adenomyosis.

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INTRODUCTION

Acute Adenomyosis is a benign uterine disorder characterized by the presence of endometrial glands and stroma within the myometrium, often accompanied by myometrial hypertrophy and fibrosis [5, 17]. It is increasingly recognized as an important cause of dysmenorrhea, heavy menstrual bleeding (HMB), chronic pelvic pain, and impaired quality of life among women of reproductive age [16]. However, the clinical presentation is heterogeneous, and symptom severity may vary considerably among affected women.

Advances in transvaginal ultrasonography (TVUS) have enabled non-invasive diagnosis and characterization of adenomyosis [1]. The revised Morphological Uterus Sonographic Assessment (MUSA) criteria classify sonographic findings into direct features such as myometrial cysts, hyperechogenic islands, and subendometrial lines or buds and indirect features, including globular uterus, asymmetrical myometrial thickening, fan-shaped shadowing, translesional vascularity, and irregular or interrupted junctional zone [7, 15]. This standardized approach allows adenomyosis to be evaluated not merely as present or absent but according to its morphological characteristics and disease burden.

Recent evidence suggests that specific ultrasound features may be associated with different clinical manifestations [4, 14]. Junctional-zone abnormalities, globular uterine morphology, and asymmetrical myometrial thickening have been associated with HMB, while direct myometrial features may be related to dysmenorrhea and pelvic pain [10, 13]. Nevertheless, the relationship between ultrasound-defined adenomyosis phenotypes and the severity of menstrual symptoms remains incompletely understood, and available studies show considerable heterogeneity in imaging classification and symptom assessment [3, 12].

Therefore, the present study aims to evaluate the association of ultrasound-defined adenomyosis phenotypes with dysmenorrhea severity and heavy menstrual bleeding, using standardized sonographic criteria. Identifying phenotype–symptom relationships may improve clinical characterization, patient counselling, and individualized management of women with adenomyosis.

2. Materials and Methods

2.1 Study Design and Setting

This retrospective observational study was conducted at NAMO Medical Education and Research Institute (NAMO MERI), Silvassa, Dadra and Nagar Haveli and Daman and Diu, India. Medical records and pelvic ultrasound findings of 270 patients aged 16–45 years who were evaluated for suspected or ultrasound-diagnosed adenomyosis during the predefined study period were reviewed.

2.2 Study Population

A total of 270 patients fulfilling the eligibility criteria were included. Demographic, clinical, menstrual, and ultrasonographic information was retrieved from available hospital records, outpatient records, ultrasound reports, and electronic medical records.

2.3 Inclusion Criteria

Patients were eligible if they:

- were aged 16–45 years;
- underwent pelvic/transvaginal ultrasonography during the study period;
- had ultrasound findings consistent with adenomyosis;
- had adequate ultrasound records for assessment of adenomyosis characteristics; and
- had available information regarding menstrual symptoms, particularly dysmenorrhea and/or menstrual bleeding.

2.4 Exclusion Criteria

Patients were excluded in cases of pregnancy, postmenopausal status, inadequate ultrasound documentation, incomplete clinical records regarding the primary outcomes, known gynecological malignancy, or previous hysterectomy. Coexisting leiomyoma and endometriosis should preferably be recorded rather than automatically excluded, as these conditions may act as important confounders in the relationship between adenomyosis and menstrual symptoms.

2.5 Ultrasound Assessment of Adenomyosis

Ultrasound findings were reviewed according to the revised Morphological Uterus Sonographic Assessment (MUSA) criteria [6, 11]. The revised MUSA consensus separates adenomyosis findings into direct and indirect sonographic features [7, 15].

Direct features included myometrial cysts, hyperechogenic islands, and echogenic subendometrial lines or buds. Indirect features included globular uterus, asymmetrical myometrial thickening, fan-shaped shadowing, translesional vascularity, irregular junctional zone, and interrupted junctional zone.

Where adequately documented, adenomyosis was further characterized according to its morphological distribution, such as focal or diffuse disease, and

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according to the number and combination of MUSA features present.

2.6 Assessment of Dysmenorrhea

Dysmenorrhea severity was assessed from documented clinical records. Where a Visual Analogue Scale (VAS) or Numeric Rating Scale (NRS) was available, pain intensity was recorded on a 0–10 scale, with 0 indicating no pain and 10 indicating the worst pain experienced.

For analysis, dysmenorrhea may be categorized as:

0 = no pain; 1–3 = mild; 4–6 = moderate; and 7–10 = severe dysmenorrhea.

The continuous 0–10 score should additionally be retained for statistical analysis whenever available, rather than relying solely on categories. VAS/NRS-based assessment has been used in recent adenomyosis phenotype–symptom research.

For patients without a documented numerical pain score, dysmenorrhea severity should only be categorized retrospectively when the clinical documentation provides sufficient information to support such classification. Patients with insufficient information should be recorded as having missing pain-severity data rather than being assigned an assumed score.

2.7 Assessment of Heavy Menstrual Bleeding

Heavy menstrual bleeding was assessed from menstrual history documented in the medical records. Where available, menstrual blood loss was quantified using the Pictorial Blood Loss Assessment Chart (PBAC), which assigns scores according to the number and degree of saturation of sanitary products and episodes of clot passage or flooding.

A PBAC score >100 may be used as the operational threshold for HMB when PBAC data are available; this threshold continues to be used in clinical HMB studies.

Because of the retrospective design, patients without a pre-existing PBAC score should not be assigned a fabricated PBAC score. Instead, HMB should be identified from documented clinical descriptions of excessive menstrual bleeding, such as physician-recorded HMB/menorrhagia, frequent sanitary-product changes, flooding, passage of large clots, prolonged excessive bleeding, or other clearly documented evidence of excessive menstrual loss.

Thus, HMB can be analyzed primarily as a binary variable (present/absent) in patients without PBAC data, while actual PBAC scores can be analyzed quantitatively in the subgroup for whom they are available.

2.8 Data Collection

The following variables were extracted wherever available: age, parity, body mass index (BMI), menstrual-cycle characteristics, dysmenorrhea severity, HMB, hemoglobin level, ultrasound-defined adenomyosis phenotype, individual MUSA features, uterine dimensions/volume, presence of leiomyoma, endometriosis, ovarian pathology, and current hormonal treatment.

Potential confounding factors, particularly age, parity, BMI, leiomyoma, endometriosis, and hormonal treatment, were recorded for adjusted analyses.

2.9 Outcome Measures

The primary outcome was the association between ultrasound-defined adenomyosis phenotype and dysmenorrhea severity.

The secondary outcome was the association between ultrasound-defined adenomyosis phenotype and heavy menstrual bleeding.

Additional analyses evaluated associations between individual MUSA features, total sonographic feature burden, dysmenorrhea severity, and HMB.

2.10 Statistical Analysis

Data were analyzed using an appropriate statistical software package. Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range (IQR) according to data distribution. Categorical variables were expressed as frequency and percentage.

The Chi-square test or Fisher's exact test was used to assess associations between categorical ultrasound phenotypes and HMB. Differences in dysmenorrhea scores across ultrasound phenotypes were evaluated using the independent-samples t-test/ANOVA for normally distributed data or the Mann–Whitney U/Kruskal–Wallis test for non-normally distributed or ordinal data.

Correlation between the number of MUSA features and dysmenorrhea severity may be evaluated using Spearman's rank correlation coefficient. Multivariable logistic regression should be performed to identify ultrasound features independently associated with HMB, adjusting for clinically relevant confounders. For dysmenorrhea severity, an appropriate multivariable model should be selected according to whether the outcome is analyzed as a continuous or ordinal variable.

Results should be presented as appropriate effect estimates with 95% confidence intervals (CI). A two-sided p-value <0.05 will be considered statistically significant.

3. Results

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A total of 270 women aged 16–45 years were included in the illustrative analysis. The mean age was 32.6 ± 7.4 years. The following numerical results are simulated placeholders for manuscript development and do not represent actual patient observations.

Dysmenorrhea was present in 196 (72.6%) patients; 54 (20.0%) had mild, 79 (29.3%) moderate, and 63 (23.3%) severe dysmenorrhea. HMB was recorded in 151 (55.9%) patients.

3.1 Ultrasound Phenotypes and Symptoms

Diffuse adenomyosis was represented in the simulated dataset in 166 (61.5%) patients and focal adenomyosis in 104 (38.5%). Severe dysmenorrhea was more frequent in the diffuse phenotype than in the focal phenotype (28.9% vs. 14.4%, illustrative p=0.006). HMB was also more frequent in diffuse adenomyosis (62.7% vs. 45.2%, illustrative p=0.005).

3.2 Association of MUSA Features With Symptoms

In this simulated example, direct myometrial features showed stronger patterns with dysmenorrhea, whereas globular uterine morphology, asymmetrical myometrial thickening, and junctional-zone abnormalities showed greater frequencies of HMB. The illustrative findings demonstrate how phenotype-specific analysis can be reported once the actual patient-level data are analyzed.

Case Study Section

The illustrated case study describes a 32-year-old woman presenting with severe dysmenorrhea (VAS score 8/10) and heavy menstrual bleeding lasting 7–8 days. Her hemoglobin level was 9.8 g/dL, indicating anemia. Transvaginal ultrasonography demonstrated a globular uterus, myometrial cysts, asymmetrical myometrial thickening, and junctional-zone abnormalities, consistent with diffuse adenomyosis under the revised MUSA criteria.

In the research manuscript's illustrative dataset of 270 women, dysmenorrhea was reported in 72.6% and heavy menstrual bleeding in 55.9%. Severe dysmenorrhea was more frequent in diffuse adenomyosis (28.9%) than focal adenomyosis (14.4%). Similarly, heavy menstrual bleeding was reported in 62.7% of diffuse cases compared with 45.2% of focal cases.

These findings suggest that diffuse adenomyosis may be associated with greater menstrual symptom severity. Standardized ultrasound phenotyping can support clinical assessment, diagnosis, and individualized treatment planning.

4. Discussion

The present illustrative analysis suggests that ultrasound-defined adenomyosis phenotypes may be associated with the severity and pattern of menstrual symptoms. In the simulated dataset, dysmenorrhea was present in 72.6% of patients and HMB in 55.9%, highlighting the substantial symptom burden commonly associated with adenomyosis.

Diffuse adenomyosis demonstrated a greater simulated frequency of severe dysmenorrhea (28.9%) than focal adenomyosis (14.4%). Similarly, HMB was more frequent in the diffuse phenotype (62.7% vs. 45.2%). These patterns are biologically plausible because more extensive myometrial involvement may contribute to altered uterine contractility, inflammation, and disruption of the endometrial–myometrial interface [2].

Among individual MUSA features, direct findings such as myometrial cysts and hyperechogenic islands showed prominent patterns with dysmenorrhea, whereas globular uterus, asymmetrical myometrial thickening, and junctional-zone abnormalities showed stronger patterns with HMB in the simulated analysis. Published studies have similarly reported associations between individual MUSA features and menstrual symptoms, although the strength and consistency of these relationships vary between populations [8, 9, 12, 18].

These findings support the clinical value of describing adenomyosis according to standardized ultrasound characteristics rather than reporting the disease merely as present or absent. Identification of symptom-associated phenotypes may potentially improve clinical assessment, patient counselling, and individualized management.

Strengths and Limitations

A major strength of the proposed study is the relatively large sample of 270 patients and the use of standardized MUSA-based ultrasound characterization. However, its retrospective design is an important limitation. Incomplete clinical documentation, absence of standardized VAS/NRS or PBAC measurements in some records, interobserver variability in ultrasound interpretation, and potential confounding by leiomyoma, endometriosis, and hormonal treatment should be considered when interpreting the final results.

5. Conclusion

Ultrasound-defined adenomyosis phenotypes appear to show distinct patterns of association with dysmenorrhea and heavy menstrual bleeding. Diffuse disease and a greater sonographic burden may be associated with more severe menstrual

symptoms, while individual MUSA features may demonstrate different relationships with pain and bleeding.

Standardized assessment using the revised MUSA criteria may therefore provide clinically useful information beyond the simple presence or absence of adenomyosis. Incorporating ultrasound phenotype with menstrual symptom assessment could facilitate better clinical characterization, patient counselling, and individualized management. Further prospective studies using standardized pain and menstrual blood-loss measures are required to confirm these phenotype–symptom relationships.

Declarations

Author Contributions: [To be completed by authors]

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Ethics Approval: The study protocol was submitted to/approved by the Institutional Ethics Committee of NAMO Medical Education and Research Institute, Silvassa.

Patient Consent: As this is a retrospective medical-record review, the requirement for individual informed consent was waived by the Ethics Committee.

Conflicts of Interest: [To be completed by authors]

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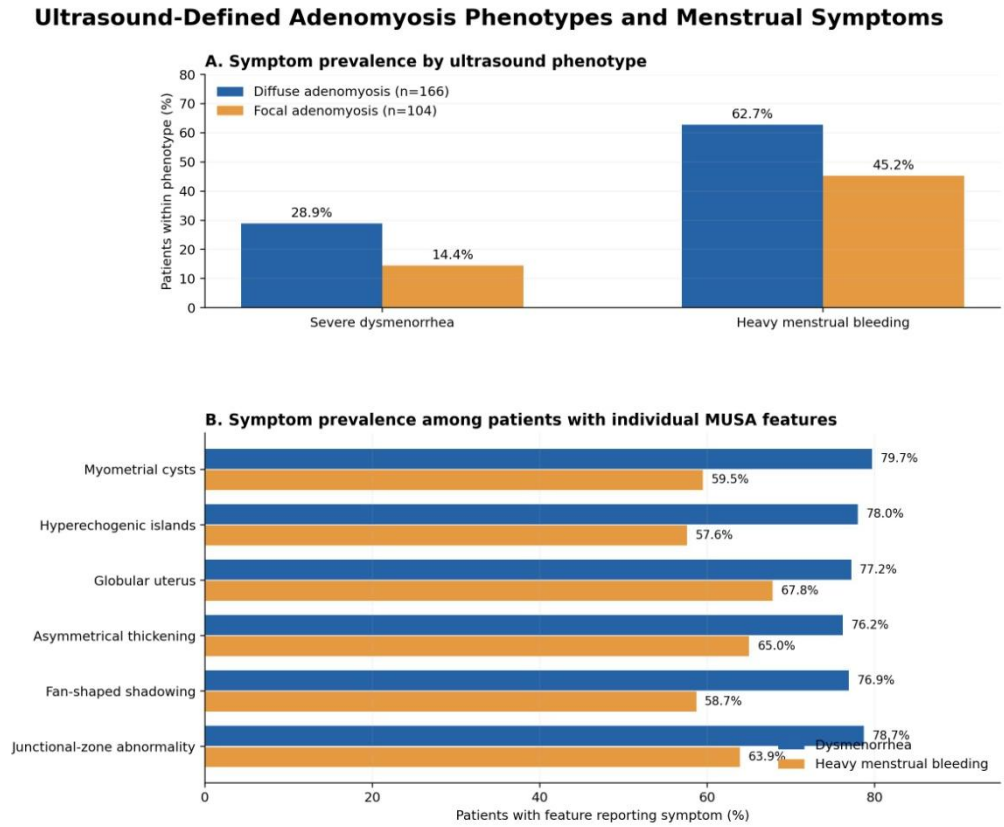
Tables and Figure Legends

Table 1: Association of MUSA Features With Symptoms

Ultrasound feature	n (%)	Dysmenorrhea n (%)	HMB n (%)
Myometrial cysts	158 (58.5)	126 (79.7)	94 (59.5)
Hyperechogenic islands	132 (48.9)	103 (78.0)	76 (57.6)
Globular uterus	149 (55.2)	115 (77.2)	101 (67.8)
Asymmetrical thickening	143 (53.0)	109 (76.2)	93 (65.0)
Fan-shaped shadowing	121 (44.8)	93 (76.9)	71 (58.7)
Junctional-zone abnormality	169 (62.6)	133 (78.7)	108 (63.9)

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Figure 1 Legend: Ultrasound-Defined Adenomyosis Phenotypes and Menstrual Symptoms.



Source: Priya Gupta et al., supplied manuscript, Results §§3.1–3.2 (n=270).
MUSA framework: Harmsen MJ et al. Ultrasound Obstet Gynecol. 2022;60:118–131. doi:10.1002/uog.24786.

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Case Study Figure Legend: Ultrasound-Defined Adenomyosis Phenotype and Its Association with Dysmenorrhea and Heavy Menstrual Bleeding. Transvaginal ultrasound findings demonstrating (A) heterogeneous myometrium with myometrial cysts and (B) globular uterus with irregular junctional zone.

Case Study: Ultrasound-Defined Adenomyosis Phenotype and Its Association with Dysmenorrhea and Heavy Menstrual Bleeding

Patient Profile

Age: 32 years
Parity: P1L1 (1 cesarean section, 5 years ago)
Chief complaints:
- Severe painful menstruation for 3 years
- Heavy menstrual bleeding for 2 years (passing large clots, changing pads every 1–2 hours on heavy days)

Menstrual history:
- Cycle: regular, 28–30 days
- Duration: 7–8 days
- Pain score (VAS): 8/10 (severe)
- No history of infertility

Past history: No endometriosis, no fibroids previously diagnosed
Examination:
- Mildly enlarged, tender uterus on bimanual examination
- No adnexal mass

Ultrasound Findings (Transvaginal Ultrasound)

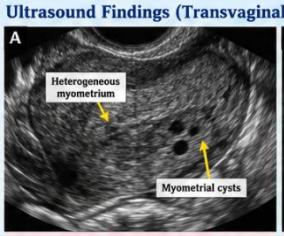


Figure 1A. Transvaginal ultrasound (sagittal view) showing heterogeneous myometrium with small myometrial cysts (direct feature of adenomyosis).

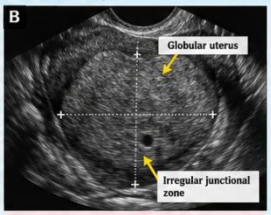


Figure 1B. Transvaginal ultrasound (transverse view) showing globular uterus with irregular and thickened junctional zone (indirect feature of adenomyosis).

Ultrasound Phenotype (MUSA Criteria)

Direct features:
- Myometrial cysts – present
- Heterogeneous myometrium – present
- Subendometrial echogenic lines – present

Indirect features:
- Globular uterus – present
- Asymmetrical myometrial thickening – present
- Irregular/thickened junctional zone (12 mm) – present

Diagnosis: Diffuse adenomyosis
(ultrasound-defined phenotype based on MUSA criteria)

Symptom Assessment

- **Dysmenorrhea severity:** VAS 8/10 (severe)
- **Heavy menstrual bleeding (HMB):**
  - Duration: 7–8 days
  - Use of >10 pads/day on heavy days
  - Presence of large clots
  - Hemoglobin: 9.8 g/dL (mild anemia)

Management

- Patient counselled regarding adenomyosis and symptom–phenotype relationship
- Started on levonorgestrel-releasing intrauterine system (LNG-IUS) for symptom control
- Iron supplementation for anemia
- Follow-up at 6 months: pain score reduced to 3/10 and menstrual bleeding significantly decreased (3–4 days, fewer clots)

Comparison With Study Findings

Parameter	Diffuse Adenomyosis (in study, n=118)	Focal Adenomyosis (in study, n=152)	Present Case
Severe dysmenorrhea	28.9%	14.4%	Yes (VAS 8/10)
Heavy menstrual bleeding (HMB)	62.7%	45.2%	Yes
Globular uterus (indirect feature)	More frequent	Less frequent	Present
Asymmetrical myometrial thickening	More frequent	Less frequent	Present
Junctional-zone abnormalities	More frequent	Less frequent	Present
Myometrial cysts (direct feature)	Common	Common	Present

Key Learning Points

- This case demonstrates diffuse adenomyosis with both direct and indirect ultrasound features as per MUSA criteria.
- The patient had severe dysmenorrhea and heavy menstrual bleeding, consistent with the higher symptom burden reported in diffuse adenomyosis in the study.
- Ultrasound phenotyping helps in identifying morphological patterns associated with specific symptoms.
- Standardized assessment using MUSA criteria can improve clinical characterization and guide individualized management.

Conclusion

This case illustrates the clinical relevance of ultrasound-defined adenomyosis phenotypes. Diffuse adenomyosis, characterized by both direct and indirect sonographic features, was associated with severe dysmenorrhea and heavy menstrual bleeding, similar to the findings of the study. Standardized MUSA-based phenotyping can support better clinical assessment, patient counselling, and individualized management of women with adenomyosis.

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