

Original Article

Comparison of Endometrial Thickness Measurements in Women with Normal and Abnormal Uterine Bleeding Using Ultrasonography

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ABSTRACT

Background: Abnormal uterine bleeding (AUB) is common among reproductive-age women and may arise from structural or nonstructural gynecological causes. Endometrial thickness (ET) can be measured noninvasively with ultrasonography, but interpretation in premenopausal women is complicated by physiological variation across the menstrual cycle. **Objective:** To evaluate endometrial thickness in women with normal and abnormal uterine bleeding and compare ET across menstrual-flow categories using ultrasonography. **Methods:** This comparative cross-sectional observational study included 80 women aged 20–45 years at Bahawal Victoria Hospital, Bahawalpur. ET was measured by transabdominal ultrasonography using a Toshiba Xario system with a 2.5–5 MHz probe in the midsagittal plane at the thickest portion of the endometrium. Menstrual characteristics, body mass index, cycle phase, uterine dimensions, and orientation were recorded. ET was compared among light, moderate, and heavy menstrual-flow groups using one-way ANOVA with Tukey post-hoc comparisons. **Results:** Mean age was 31.2±6.85 years. Sixty women (75.0%) were classified as having abnormal uterine bleeding and 60 (75.0%) reported heavy menstrual flow. Mean ET was 4.08±1.44 mm in the light-flow group, 5.74±1.17 mm in the moderate-flow group, and 12.63±1.22 mm in the heavy-flow group. The overall difference was substantial ($F(2,77)=294.18$, $p<0.001$; $\eta^2=0.884$). Tukey comparisons showed differences of 1.66 mm between moderate and light flow, 8.55 mm between heavy and light flow, and 6.89 mm between heavy and moderate flow. **Conclusion:** Endometrial thickness differed markedly across menstrual-flow categories, with the greatest thickness observed among women reporting heavy flow. Because cycle phase was not controlled across groups and no histopathological reference standard was used, the findings demonstrate association rather than a diagnostic threshold for endometrial pathology. **Keywords:** Endometrial Thickness; Abnormal Uterine Bleeding; Ultrasonography; Heavy Menstrual Bleeding; Transabdominal Ultrasound.

INTRODUCTION

Abnormal uterine bleeding is a common gynecological presentation among women of reproductive age and encompasses disturbances in the frequency, regularity, duration, or volume of uterine bleeding. AUB can substantially impair quality of life and may arise from structural uterine abnormalities, ovulatory dysfunction, primary endometrial disorders, coagulopathy, iatrogenic factors, or other causes (1–3).

Contemporary terminology emphasizes standardized description of bleeding symptoms and classification of underlying causes. FIGO System 1 characterizes abnormal bleeding by frequency, duration, regularity, and flow volume, whereas FIGO System 2 classifies etiologies using PALM-COEIN: structural causes—polyp, adenomyosis, leiomyoma, malignancy/hyperplasia—and nonstructural causes—coagulopathy, ovulatory dysfunction, endometrial, iatrogenic, and not otherwise classified (2,4). Such classification is particularly useful because AUB is a symptom complex rather than a single disease entity (2,3).

The endometrium undergoes predictable cyclical change in response to ovarian hormones. Estrogen promotes endometrial proliferation during the proliferative phase, while progesterone after ovulation produces secretory transformation and prepares the endometrium for implantation. In the absence of pregnancy, hormonal withdrawal results in endometrial shedding. Consequently, endometrial thickness in reproductive-age women varies substantially with menstrual-cycle phase and cannot be interpreted independently of cycle timing (5,6).

Ultrasonography is central to structural assessment in women with AUB. Endometrial thickness is measured as the double-layer thickness of the endometrial echo in the midsagittal uterine plane. Transvaginal ultrasonography provides high-resolution endometrial assessment, but in reproductive-age women ET is not itself a diagnosis; it is one imaging characteristic that should be interpreted alongside age, cycle phase, symptoms, risk factors, endometrial morphology, and other uterine findings (7–9).

Endometrial hyperplasia, polyps, submucosal leiomyomas, and other structural abnormalities can alter the appearance or thickness of the endometrium. Conversely, abnormal bleeding may also occur in the absence of marked endometrial thickening. This distinction is important because AUB may result from ovulatory or endometrial functional disorders even when structural imaging is relatively unremarkable (2,4,8,9).

Published studies evaluating ET in women with AUB have produced different thresholds and diagnostic performance estimates because populations, menopausal status, cycle timing, ultrasonographic technique, and reference standards differ. Ozdemir et al. evaluated premenopausal women with abnormal bleeding using transvaginal ultrasonography and histopathology and demonstrated that ET may contribute to evaluation of endometrial abnormality, while emphasizing the need for clinical context (10). Ozer et al. similarly demonstrated correlations between transvaginal ultrasound findings and histopathology in women with AUB (11). More recent evidence likewise indicates that pelvic ultrasonography is useful in premenopausal AUB, but its prediction of endometrial neoplasia remains context-dependent rather than reducible to a single ET value (9).

Evidence derived from perimenopausal or postmenopausal populations should not be transferred directly to younger reproductive-age women. For example, Kumari et al. evaluated an ET cutoff for prediction of endometrial pathology specifically in perimenopausal women with AUB (12). Such thresholds reflect a different hormonal and baseline-risk environment and therefore should not automatically be adopted for women in their twenties and thirties (8,12).

When imaging raises concern for endometrial pathology, tissue assessment may be indicated according to clinical risk and presentation. Endometrial biopsy remains an established method for histological evaluation, but risk-based decisions in premenopausal women should integrate age, persistence and pattern of bleeding, obesity and other metabolic or reproductive risk factors, imaging findings, and clinical context rather than ET alone (13–15).

Most published diagnostic studies have used transvaginal ultrasonography because of its proximity to the uterus and higher spatial resolution, and TVS is generally preferred for detailed endometrial assessment (8). Transabdominal ultrasonography nevertheless remains clinically useful when TVS is unavailable, unacceptable, contraindicated, or impractical, particularly in resource-limited settings; physiological cycle-related variation remains relevant to interpretation of transabdominal ET measurements (6,8). The diagnostic implications of measurements obtained transabdominally should therefore be interpreted according to the modality and adequacy of endometrial visualization (8,9).

The present study evaluated endometrial thickness and uterine characteristics in women aged 20–45 years at Bahawal Victoria Hospital, Bahawalpur. It aimed to compare ET across bleeding patterns and describe how endometrial thickness varied with menstrual-flow severity within this reproductive-age population.

MATERIALS AND METHODS

Study Design and Setting

A comparative cross-sectional observational study was conducted at Bahawal Victoria Hospital, Bahawalpur, over four months. Eighty women were included in the completed analysis.

Participants

Women with normal menstrual cycles or abnormal uterine bleeding were recruited for ultrasonographic evaluation. The analyzed participants were 20–45 years of age.

Pregnant women, women with known malignancy, women with previous uterine surgery affecting the endometrium, and women receiving hormonal therapy were excluded.

Written informed consent was obtained before participation. Ethical approval was obtained for the study, and confidentiality and anonymity were maintained.

Clinical and Menstrual Assessment

Clinical history and examination were performed before ultrasound assessment. Recorded variables included age, body mass index, menstrual duration, menstrual-flow category, bleeding presentation, menstrual-cycle phase, bleeding status, uterine orientation, and uterine dimensions.

Menstrual flow was classified as light, moderate, or heavy. Bleeding status was recorded separately as normal or abnormal. Menstrual phase at the time of assessment was recorded as menstrual, proliferative, or secretory.

Ultrasonographic Assessment

Endometrial thickness was assessed primarily using transabdominal ultrasonography with a Toshiba Xario ultrasound system and a 2.5–5 MHz probe.

The uterus was visualized in the midsagittal plane. ET was measured at the thickest portion of the endometrial lining as the double-layer endometrial thickness, consistent with standard sonographic measurement principles (7,8). Multiple measurements were obtained and averaged for analysis.

Uterine length and width were also recorded, together with uterine orientation as anteverted or retroverted.

Statistical Analysis

Descriptive statistics were used to summarize demographic, menstrual, and ultrasonographic characteristics. Continuous variables were expressed as mean±standard deviation and range, while categorical variables were summarized using frequencies and percentages.

Endometrial thickness was compared among light-, moderate-, and heavy-flow groups using one-way analysis of variance. Tukey's honestly significant difference procedure was used for post-hoc pairwise comparison.

Using the supplied group sizes, means, and standard deviations, the omnibus ANOVA statistic, Tukey-adjusted mean-difference confidence intervals, and eta-squared effect size were deterministically recalculated. A two-sided p value <0.05 was considered statistically significant.

No diagnostic-accuracy analysis was performed because histopathology or another independent reference standard was not part of the available study results.

RESULTS

Eighty women aged 20–45 years were included. Mean age was 31.2±6.85 years.

Half of participants had a BMI classified as normal, while 32.5% were underweight, 13.8% overweight, and 3.8% obese.

Menstrual bleeding lasted 2–4 days in 15 women, 5–7 days in 36, and >7 days in 29. Menstrual flow was classified as light in 10 women, moderate in 10, and heavy in 60.

The recorded bleeding presentation was spotting in 20 women and menorrhagia/heavy menstrual bleeding in 60. Bleeding status was recorded separately as normal in 20 women and abnormal in 60.

At examination, 25 women were in the menstrual phase, 29 in the proliferative phase, and 26 in the secretory phase.

Mean uterine length was 7.15±1.52 cm and mean width 4.02±0.85 cm. Forty-eight women had an anteverted uterus and 32 a retroverted uterus.

Table 1. Demographic, Menstrual, and Uterine Characteristics

Domain	Variable	n / Value	% / Range
Sample	Participants	80	100.0
Age	Mean $\pm$ SD	31.2 $\pm$ 6.85 years	20–45
BMI	Underweight	26	32.5
	Normal	40	50.0
	Overweight	11	13.8
	Obese	3	3.8
Bleeding duration	2–4 days	15	18.8
	5–7 days	36	45.0
	>7 days	29	36.3
Menstrual flow	Light	10	12.5
	Moderate	10	12.5
	Heavy	60	75.0
Recorded bleeding presentation	Spotting	20	25.0
	Menorrhagia/heavy bleeding	60	75.0
Bleeding status	Normal	20	25.0
	Abnormal	60	75.0
Cycle phase	Menstrual	25	31.3
	Proliferative	29	36.3
	Secretory	26	32.5
Uterine length	Mean $\pm$ SD	7.15 $\pm$ 1.52 cm	3.3–10.4
Uterine width	Mean $\pm$ SD	4.02 $\pm$ 0.85 cm	2.5–5.4
Uterine orientation	Anteverted	48	60.0
	Retroverted	32	40.0

Mean ET in the complete sample was 10.70 $\pm$ 3.60 mm, ranging from 2.2 to 15.2 mm.

A marked gradient in ET was present across the menstrual-flow groups. Mean ET was 4.08 $\pm$ 1.44 mm in women with light flow, 5.74 $\pm$ 1.17 mm in those with moderate flow, and 12.63 $\pm$ 1.22 mm in those with heavy flow.

The reconstructed one-way ANOVA demonstrated a large overall difference among groups: $F(2,77)=294.18$, $p<0.001$. The corresponding eta-squared value was 0.884, indicating that a large proportion of observed ET variability in this sample was associated with the three recorded flow categories.

Table 2. Endometrial Thickness According to Menstrual-Flow Category

Flow Category	n	Mean ET $\pm$ SD, mm	Range, mm
Light	10	4.08 $\pm$ 1.44	2.2–5.8
Moderate	10	5.74 $\pm$ 1.17	3.7–7.0
Heavy	60	12.63 $\pm$ 1.22	11.0–15.2
Overall	80	10.70 $\pm$ 3.60	2.2–15.2

One-way ANOVA: $F(2,77)=294.18$, $p<0.001$; $\eta^2=0.884$.

Tukey-adjusted pairwise comparisons showed statistically significant differences between each flow category. Women with moderate flow had a mean ET 1.66 mm greater than those with light flow. The

heavy-flow group had a mean ET 8.55 mm greater than the light-flow group and 6.89 mm greater than the moderate-flow group.

Table 3. Tukey Post-Hoc Comparison of Endometrial Thickness

Comparison	Mean Difference, mm	Tukey-Adjusted 95% CI	p Value
Moderate – Light	1.66	0.33 to 2.99	0.010
Heavy – Light	8.55	7.54 to 9.56	<0.001
Heavy – Moderate	6.89	5.88 to 7.90	<0.001

The study therefore demonstrates a strong cross-sectional association between menstrual-flow category and measured endometrial thickness. The supplied data do not provide separate ET means for the binary normal-bleeding and abnormal-bleeding groups, so the principal inferential comparison is based on flow severity.

DISCUSSION

The present study found a pronounced gradient in endometrial thickness across menstrual-flow categories among women aged 20–45 years. Mean ET increased from approximately 4.1 mm in the light-flow group to 5.7 mm in the moderate-flow group and 12.6 mm in the heavy-flow group. The omnibus effect was large, and all three pairwise comparisons were statistically significant.

The magnitude of this association is notable, but it must be interpreted within the physiological context of the menstrual cycle. Endometrial thickness changes substantially between menstrual, proliferative, and secretory phases as the endometrium responds to estrogen and progesterone (5,6,8). Approximately one-third of the present participants were assessed in each phase, but phase distribution within the light-, moderate-, and heavy-flow groups was not available. Menstrual phase may therefore account for part of the observed between-group difference.

This issue is particularly important in reproductive-age women, in whom a single ET cutoff has substantially less diagnostic meaning than in postmenopausal bleeding. Standardized AUB frameworks emphasize bleeding characteristics, clinical history, structural assessment, and etiological classification rather than reliance on ET alone, while contemporary imaging evidence also cautions against interpreting premenopausal ET as an isolated predictor of endometrial neoplasia (2,4,8,9).

Previous studies in women with AUB have nevertheless demonstrated that ET can contribute useful clinical information. Ozdemir et al. compared transvaginal ET with histopathology in premenopausal women with abnormal bleeding and found that sonographic thickness was associated with endometrial pathology (10). Ozer et al. similarly reported associations between transvaginal ultrasound-measured ET and histopathological findings (11). Recent premenopausal data continue to support pelvic ultrasound as an important component of evaluation while showing that predictive performance depends on the broader bleeding and risk profile (9).

Those studies differ importantly from the present investigation because histopathology was not used as a reference standard here. Consequently, a thick endometrium in the current study cannot be assumed to represent hyperplasia, polyps, malignancy, or another specific pathological process. The findings demonstrate a relationship with bleeding intensity, not diagnostic accuracy for tissue pathology; diagnostic claims would require comparison against an appropriate reference standard such as endometrial sampling or histopathology (9,13).

The heavy-flow group had a mean ET of 12.63 mm. Although this value falls above thresholds proposed in some perimenopausal AUB studies, applying such thresholds directly to the present population would be inappropriate. Kumari et al., for example, investigated perimenopausal women and assessed ET against histopathology, which differs both in age distribution and reference-standard methodology from the present study (12). Reviews of thickened endometrium likewise emphasize that clinically useful ET thresholds differ according to menopausal status, symptoms, and context (8).

This population distinction is essential because the current participants were 20–45 years old and therefore predominantly reproductive-age women. Postmenopausal ET thresholds—particularly the commonly discussed low-millimetre thresholds used in postmenopausal bleeding—should not be used to classify these women. Endometrial physiology, baseline disease prevalence, and the diagnostic meaning of ET differ across reproductive and postmenopausal populations (8,9).

Body mass index may also influence endometrial risk in premenopausal women with AUB. Higher BMI and obesity have been associated with increased likelihood of endometrial intraepithelial neoplasia, hyperplasia, or malignancy in risk-based sampling studies, although BMI should be interpreted alongside other reproductive and clinical factors rather than in isolation (14,15). Half of the study population had a normal BMI, 32.5% were underweight, 13.8% overweight, and 3.8% obese. However, BMI distribution was not available separately for the flow or bleeding groups, so its influence on ET differences cannot be assessed.

Similarly, uterine size and orientation were described in the overall cohort. Mean uterine length was 7.15 cm and mean width 4.02 cm; 60% of uteri were anteverted and 40% retroverted. These findings characterize the study population but do not establish whether uterine dimensions or orientation were associated with normal versus abnormal bleeding because no valid group comparison was supplied.

Transabdominal ultrasonography was used for ET measurement in this study. TAS is accessible and noninvasive and can be useful where transvaginal imaging is unavailable or unsuitable, but detailed endometrial assessment is generally better characterized with high-resolution transvaginal imaging (8). Transabdominal measurements are also dependent on image quality, acoustic window, uterine position, and adequate visualization of the endometrial interfaces; these modality-related considerations should be recognized when comparing the present ET values with studies conducted primarily using transvaginal ultrasonography (6,8,9).

The study recorded 60 women with abnormal uterine bleeding and 20 with normal bleeding. The same 60:20 distribution also appears in the heavy-flow versus combined light/moderate categories and in the menorrhagia-versus-spotting data. Without an explicit participant-level cross-tabulation, these variables should not be assumed to represent identical classifications. The statistically supportable analysis is therefore the direct light-, moderate-, and heavy-flow comparison.

Endometrial thickness should consequently be regarded as one component of AUB assessment rather than a stand-alone screening test. When clinical features or imaging raise concern for endometrial pathology, histological assessment may be required according to the patient's age, persistence and pattern of bleeding, metabolic and reproductive risk factors, imaging findings, and overall clinical presentation (2,13–15).

The study has several strengths. ET was measured using a defined sonographic plane and a specified ultrasound system, multiple readings were averaged, menstrual phase was recorded, and the supplied summary data allowed rigorous reconstruction of the ANOVA and Tukey comparisons without generating participant-level observations.

The principal limitations are equally important. Only 80 participants were analyzed despite a larger stated target sample. Sampling methodology was unclear. Menstrual phase was not controlled or adjusted across flow groups, and the study did not provide binary normal-versus-abnormal ET means despite this being central to the title and objective. No histopathological reference standard was available. Ultrasound was primarily transabdominal, and interobserver or intraobserver reproducibility was not reported. The study also did not provide group-stratified age, BMI, uterine dimensions, or structural uterine diagnoses.

The reported correlation between ET and bleeding cannot be interpreted confidently without knowing how the bleeding variable was coded, and it was therefore not used as a principal inferential result. Likewise, a paired-samples t-test is not appropriate for comparison of independent bleeding groups unless repeated paired measurements actually exist.

Future studies should recruit adequate prespecified sample sizes, use a clearly defined sampling strategy, standardize ultrasound technique and bladder preparation, document cycle day and menstrual phase, and report ET separately for well-defined normal and AUB groups (2,6,9). Where the objective is diagnostic performance for endometrial pathology, histopathological correlation and prespecified thresholds are required (9,12,13). Multivariable analysis should also consider age, BMI, cycle phase, ovulatory status, medication exposure, and structural uterine abnormalities, because risk-based evidence indicates that clinical predictors modify the probability of significant endometrial pathology in younger women with AUB (14,15).

CONCLUSION

Endometrial thickness differed markedly according to menstrual-flow severity in women aged 20–45 years. Women reporting heavy menstrual flow had substantially greater mean ET than those with moderate or light flow, and all pairwise flow-category differences were statistically significant.

These findings demonstrate a strong cross-sectional association between ET and bleeding intensity. They do not establish a diagnostic cutoff for endometrial pathology, prove causality, or replace histopathological assessment when clinically indicated.

Ultrasonographic ET measurement can contribute useful information to the evaluation of abnormal uterine bleeding, but interpretation in reproductive-age women should incorporate menstrual-cycle phase, clinical presentation, risk factors, and the imaging modality used.

RECOMMENDATIONS

Endometrial thickness should be interpreted as part of a structured AUB assessment rather than as an isolated diagnostic test.

Future studies should compare clearly defined normal-bleeding and AUB groups directly, standardize the menstrual-cycle phase or adjust statistically for phase, and use transvaginal ultrasonography where clinically appropriate to improve endometrial visualization.

Studies intended to derive diagnostic ET thresholds should include an appropriate histopathological reference standard and report sensitivity, specificity, predictive values, and confidence intervals.

Cycle day, ovulatory status, BMI, age, medication use, uterine structural abnormalities, and relevant metabolic risk factors should be documented prospectively.

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