e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.12.90

International Journal of Pharmaceutical Quality Assurance 2025; 16(12); 543-549

Original Research Article

Evaluation of Endometrial Thickness Cut-Offs Using Transvaginal Ultrasonography for Predicting Histopathological Abnormalities in Abnormal Uterine Bleeding

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Received: 03-10-2025 / Revised: 14-11-2025 / Accepted: 29-12-2025

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Conflict of interest: Nil

Abstract:

Background: Abnormal uterine bleeding (AUB) in perimenopausal women may indicate underlying benign, premalignant, or malignant endometrial pathology. Transvaginal ultrasonography (TVS) provides a non-invasive method to assess endometrial thickness (ET) and predict histopathological abnormalities.

Aim: To evaluate optimal endometrial thickness cut-offs using TVS for predicting abnormal endometrial histology in perimenopausal women with AUB.

Methodology: In this cross-sectional study, 60 perimenopausal women with AUB underwent TVS and Doppler assessment of endometrial thickness and vascularity, followed by histopathological examination. ROC curve analysis determined the optimal ET cut-off for predicting abnormal endometrium, and logistic regression identified associated risk factors.

Results: Abnormal endometrium was observed in 18/60 (30%) cases. Mean ET was significantly higher in abnormal (14.2 ± 3.9 mm) versus normal endometrium (7.85 ± 2.6 mm, $p < 0.001$). An ET cut-off >10.5 mm showed 77.8% sensitivity, 85.7% specificity, 70% positive predictive value, and 90% negative predictive value (AUC = 0.88). Age >45 years (OR = 3.9), obesity (BMI ≥30 kg/m², OR = 3.5), and ET >10.5 mm (OR = 18.7) were significant predictors of abnormal histology.

Conclusion: TVS-measured endometrial thickness >10.5 mm is a reliable non-invasive predictor of histopathological abnormalities in perimenopausal women with AUB. Advanced age and obesity further increase risk, supporting targeted endometrial sampling in high-risk patients.

Keywords: Abnormal Uterine Bleeding, Perimenopause, Endometrial Thickness, Transvaginal Ultrasonography, Histopathology, Endometrial Hyperplasia.

Introduction

The climacteric, or perimenopausal period, is the transition period before menopause and extends to one year after permanent cessation of menses [1]. This usually occurs in women in their late 40s to early 50s and is marked by hormonal changes which cause irregular menstrual cycles. During this time, cycles may occasionally become anovulatory because of a progressive decline in the recruitment of ovarian follicles and a subsequent fall in circulating oestradiol levels. This results in a heightened incidence of prolonged cycles of amenorrhoea interspersed with episodes of heavy menstrual bleeding [2]. Thus, abnormal uterine bleeding is a common presentation in perimenopausal women, taking the form of a spectrum of menstrual abnormalities from menorrhagia and metrorrhagia through polymenorrhoea to oligomenorrhoea [3].

Accurate evaluation of AUB in perimenopausal women is clinically essential, since it may denote an underlying benign, premalignant, or malignant endometrial pathology. Traditionally, the diagnosis was heavily dependent on invasive procedures such as dilation and curettage (D&C), which, though providing tissue for histopathological examination, the gold standard, has inherent risks and patient discomfort. Through time, immunohistochemical markers, TVS, colour Doppler ultrasonography, sonosalpingography, and hysteroscopy have been added to the diagnostic armamentarium. Among these, TVS has emerged as a widely accepted,

noninvasive, and inexpensive modality for assessing endometrial morphology and thickness, following high patient tolerance and considerable clinical applicability [4].

Of these, the measurement of ET by TVS represents a particularly important modality, enabling the detection of benign and neoplastic endometrial lesions in different age groups by a reliable, reproducible, and noninvasive means [5]. In postmenopausal women, numerous studies have identified ET as an initial screening modality for endometrial pathology, where specific cut-off values have been suggested to exclude significant disease [6]. A number of studies also suggest endometrial stripe cut-off values that range widely from 3 mm to 14 mm to detect endometrial pathology in premenopausal women also [7,8],. However, despite this, there is still a relative dearth of studies that establish optimal threshold values of ET in perimenopausal women. Establishing such a threshold is very important for selecting those patients who need invasive endometrial sampling and can thus potentially avoid unnecessary procedures and their risks.

Colour Doppler ultrasonography has been investigated as an adjunct to TVS to assess endometrial vascularity. Studies assessing its diagnostic performance for predicting endometrial pathology in perimenopausal women have yielded conflicting results [9,10],. Although some studies suggest that Doppler parameters can further improve the diagnostic performance of TVS, data from other reports have generally failed to demonstrate added value reliably. Therefore, the incorporation of Doppler testing into standard AUB investigation remains a matter of controversy.

In the light of these considerations, the study was conducted to assess endometrial morphology and thickness with the help of transvaginal sonography, either alone or combined with colour Doppler studies in perimenopausal cases with abnormal uterine bleeding. The findings were further correlated with the histopathological examination of the endometrium, which is so far considered the gold standard for a proper diagnosis. The primary aim of this research is to determine an evidence-based cutoff value of endometrial thickness that may provide sufficient confidence for ruling out endometrial pathology in perimenopausal women presenting with AUB. Secondary objectives of the study are to assess whether the incorporation of Doppler ultrasonography can improve the diagnostic performance of TVS for this patient cohort. This study will help clinical practice in terms of early noninvasive prediction of endometrial pathology, decreasing unnecessary invasive procedures, and increasing the potential for appropriate care during the perimenopausal period.

Methodology

Study Design: This study was designed as a cross-sectional observational study conducted to evaluate endometrial thickness cut-offs using transvaginal ultrasonography for predicting histopathological abnormalities in women presenting with abnormal uterine bleeding.

Study Area: The study was carried out in the Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital, Agamkuan, Patna, Bihar, India.

Study Duration: The study was conducted over a period of 8 months from December 2024 to July 2025.

Study Sample: The study included perimenopausal women above 40 years of age presenting with abnormal uterine bleeding (AUB) during the study period who consented to participate. The total sample size was 60 women.

Inclusion Criteria

- Women aged >40 years with complaints of AUB.
- Willingness to provide informed consent for participation.

Exclusion Criteria

- Women with ovarian tumors or tubo-ovarian masses.
- Pregnant women.
- History or presence of genital tract malignancy.
- AUB due to medications or hormonal therapy affecting pelvic blood flow.
- Thyroid hormone disorders, coagulation disorders, or vascular malformations of the uterus.
- Continuous bleeding not controlled by antifibrinolytic therapy.

Data Collection: Data were collected from all eligible participants using a predesigned, semi-structured questionnaire after obtaining informed written consent. The questionnaire captured demographic details, menstrual history, clinical symptoms, and relevant medical history. This was followed by a thorough general physical examination and detailed gynecological examination. All participants subsequently underwent transvaginal ultrasonography for assessment of the uterus and endometrium. Findings from ultrasonography, Doppler studies, and histopathological examination were systematically recorded and compiled for analysis.

Procedure: Transvaginal ultrasonography was performed using a 7–10 MHz vaginal probe of a Philips HD11XE ultrasound machine. The uterus and adnexa were examined in longitudinal and transverse planes, and the endometrial echo complex was evaluated. The uterine image was magnified in the

sagittal plane to occupy more than two-thirds of the screen, and endometrial thickness was measured at its maximum thickness as a double-layer measurement, excluding any intra-endometrial fluid. Ultrasonography was performed between the 8th and 11th day of the menstrual cycle. In patients with continuous bleeding, antifibrinolytic therapy was administered to control bleeding, and ultrasonography was performed once bleeding was controlled; patients in whom bleeding could not be controlled were excluded.

Following grayscale ultrasonography, color Doppler imaging was performed to assess uterine and endometrial blood flow. Doppler indices including resistance index and pulsatility index were measured bilaterally from the main ascending branch of the uterine arteries at the cervical-corporal junction. Three consecutive waveforms of good quality were recorded, and the mean values were calculated. Endometrial vascular patterns were classified as single vessel, scattered vessel, or multiple vessel patterns based on Doppler flow mapping.

All participants subsequently underwent endometrial sampling. The timing of sampling varied according to the bleeding pattern: in women with cyclical bleeding, sampling was done during the premenstrual phase (days 25–27); in atypical bleeding, it was performed immediately after menstruation; and in continuous bleeding, sampling was performed on the same day. Under strict aseptic precautions, endometrial tissue was obtained using Carmen's cannula and sent in 10% formalin for histopathological examination. The final diagnosis was established by a senior pathologist.

Statistical Analysis: Data were entered into a Microsoft Excel spreadsheet and analyzed using Statistical Package for Social Sciences (SPSS) version 21.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as mean ± standard deviation or median values. Normality of data distribution was assessed using the Kolmogorov–Smirnov test. For normally distributed data, comparisons between groups were performed using the independent t-test, while non-parametric data were analyzed using the Mann–Whitney U test. Associations between categorical variables were evaluated using the chi-square test or Fisher's exact test, as appropriate.

Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal cut-off value of endometrial thickness for predicting endometrial hyperplasia or malignancy. Diagnostic performance parameters including sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios were calculated. Correlation analysis was performed using Pearson's correlation coefficient. A p-value of less than 0.05 was considered statistically significant."

Result

Table 1 compares the clinical and sonographic characteristics of participants with normal (Group I) and abnormal endometrium (Group II). Patients with abnormal endometrium were significantly older (47.3 ± 3.4 years) than those with normal endometrium (44.1 ± 2.85 years, $p = 0.001$). Obesity (BMI ≥30 kg/m²) was more prevalent in the abnormal group (38.9% vs. 14.3%, $p = 0.018$). Mean TVS endometrial thickness was markedly higher in the abnormal endometrium group (14.2 ± 3.9 mm) compared to the normal group (7.85 ± 2.6 mm, $p < 0.001$). There were no statistically significant differences in parity, hypertension, diabetes mellitus, BMI, or Doppler indices (RI and PI) between the groups ($p > 0.05$). Overall, Table 1 indicates that older age, obesity, and increased endometrial thickness are associated with abnormal endometrial histology.

Table 1: Characteristics of Study Participants

Variables	Group I (Normal Endometrium) n = 42	Group II (Abnormal Endometrium) n = 18	P value
Age (years) (Mean ± SD)	44.10 ± 2.85	47.30 ± 3.40	0.001[a]
Parity (Mean ± SD)	2.75 ± 1.40	2.60 ± 1.30	0.680[a]
Hypertension (n, %)	5 (11.9%)	4 (22.2%)	0.290[b]
Diabetes Mellitus (n, %)	4 (9.5%)	4 (22.2%)	0.190[b]
Obesity (BMI ≥30 kg/m²) (n, %)	6 (14.3%)	7 (38.9%)	0.018[b]
BMI (kg/m²) (Mean ± SD)	22.80 ± 4.10	24.10 ± 4.70	0.320[a]
Mean TVS Endometrial Thickness (mm)	7.85 ± 2.60	14.20 ± 3.90	<0.001[a]
Mean Resistance Index (RI)	0.89 ± 0.05	0.86 ± 0.06	0.090[a]
Mean Pulsatility Index (PI)	2.10 ± 0.08	2.06 ± 0.09	0.070[a]

[a]Independent t-test
[b]Chi-square test

Table 2 presents the histopathological findings of 60 endometrial samples. The majority of cases (42, 70%) showed normal proliferative or secretory endometrium. Benign lesions, such as endometrial polyps, were observed in 5 cases (8.3%). Endometrial hyperplasia without atypia was noted in 7 cases (11.7%), while hyperplasia with atypia occurred in 3 cases (5.0%), and complex hyperplasia in 2 cases

(3.3%). Malignant transformation was rare, with endometrioid adenocarcinoma identified in 1 case (1.7%). Overall, Table 2 indicates that most patients had normal endometrial histology, with a smaller proportion exhibiting premalignant or malignant changes.

Table 2: Distribution of Histopathological Findings (N = 60)		
Histopathological Diagnosis	**Number (n)**	**Percentage (%)**
Normal proliferative/secretory endometrium	42	70
Endometrial polyp	5	8.3
Simple hyperplasia without atypia	7	11.7
Simple hyperplasia with atypia	3	5
Complex hyperplasia	2	3.3
Endometrioid adenocarcinoma	1	1.7
Total	**60**	**100**

Table 3 shows the distribution of endometrial thickness measured by TVS in relation to histopathological findings. Among patients with normal endometrium, the majority (26, 61.9%) had a thickness of ≤8 mm, while only a small proportion (6, 14.3%) had thickness >10.5 mm. In contrast, abnormal endometrium was predominantly associated with thickness >10.5 mm (14, 77.7%), whereas very few cases (1, 5.6%) had thickness ≤8 mm. Intermediate thickness (8.1–10.5 mm) was less discriminatory, observed in both normal (10, 23.8%) and abnormal endometrium (3, 16.7%). Overall, Table 3 indicates a strong association between increased endometrial thickness (>10.5 mm) and histopathologically abnormal endometrium.

Table 3: Endometrial Thickness Distribution in Relation to Histopathology		
Endometrial Thickness (mm)	**Normal Endometrium n (%)**	**Abnormal Endometrium n (%)**
≤8 mm	26 (61.9%)	1 (5.6%)
8.1–10.5 mm	10 (23.8%)	3 (16.7%)
>10.5 mm	6 (14.3%)	14 (77.7%)
Total	**42 (100%)**	**18 (100%)**

Table 4 summarizes the diagnostic performance of transvaginal sonography (TVS) using an endometrial thickness cut-off of >10.5 mm. The test demonstrated good sensitivity (77.8%) and high specificity (85.7%), indicating it effectively identifies both true positives and true negatives. The positive predictive value (PPV) was 70.0%, while the negative predictive value (NPV) was higher at 90.0%, suggesting that a negative test result reliably excludes pathology. The positive likelihood ratio (LR^+) of 5.44 indicates a moderate increase in the probability of disease when the test is positive, whereas the negative likelihood ratio (LR^-) of 0.26 indicates a substantial decrease in probability when the test is negative. The area under the ROC curve (AUC) of 0.88 reflects excellent overall diagnostic accuracy. Overall, TVS with this cut-off is a reliable tool for detecting endometrial pathology.

Table 4: Diagnostic Performance of TVS Endometrial Thickness Cut-off (>10.5 mm)	
Diagnostic Parameter	**Value**
Sensitivity	77.80%
Specificity	85.70%
Positive Predictive Value (PPV)	70.00%
Negative Predictive Value (NPV)	90.00%
Positive Likelihood Ratio (LR^+)	5.44
Negative Likelihood Ratio (LR^-)	0.26
Area Under ROC Curve (AUC)	0.88

Table 5 presents univariate logistic regression analysis identifying predictors of abnormal endometrium. Age >45 years was significantly associated with abnormal endometrium (OR = 3.9; 95% CI: 1.20–12.80; p = 0.021), as was obesity (BMI ≥30 kg/m²) (OR = 3.5; 95% CI: 1.10–11.20; p = 0.032). Hypertension (OR = 1.8; p = 0.35) and diabetes mellitus (OR = 2.4; p = 0.16) were not statistically significant predictors. Endometrial thickness >10.5 mm emerged as the strongest predictor, with a markedly increased odds of abnormal endometrium (OR = 18.7; 95% CI: 4.80–72.90; p < 0.001). Overall, Table 5 indicates that advanced age, obesity, and particularly increased endometrial thickness are significant univariate predictors of abnormal endometrial histology.

Table 5: Univariate Logistic Regression Analysis for Predictors of Abnormal Endometrium			
Variable	**Odds Ratio (OR)**	**95% Confidence Interval**	**P value**
Age >45 years	3.9	1.20–12.80	0.021
Obesity (BMI ≥30 kg/m²)	3.5	1.10–11.20	0.032
Hypertension	1.8	0.50–6.50	0.35
Diabetes Mellitus	2.4	0.70–9.20	0.16
Endometrial Thickness >10.5 mm	18.7	4.80–72.90	<0.001

Discussion

Our study thus finds a significant correlation of increased ET, as measured by TVS, with abnormal endometrial histopathology in women presenting with AUB. The mean ET was significantly higher in women with abnormal endometrium, 14.20 ± 3.90 mm, as compared to that of normal endometrium, 7.85 ± 2.60 mm. Thus, this supports the finding by Giannella et al., 2019 [11], in which an ET of >11 mm was considered a sure predictor for endometrial hyperplasia and carcinoma in premenopausal women, amplifying again the role of ET in diagnosis. Similarly, Mayuri et al., 2014 [12] found an ET ≥8 mm in perimenopausal women had a sensitivity of 90.9% and specificity of 87.5% for abnormal endometrium, which is comparable to our study findings; however, the optimal cut-off in our series was slightly higher at 10.5 mm, suggesting possible population-specific variations. In contrast, Smith et al. 1991 [13] found an ET cut-off of >8 mm in premenopausal women to have a lower sensitivity of 67% and a specificity of 75%, which emphasizes the point that diagnostic accuracy can vary depending on age, menopausal status, and study methodology."

Tongsong et al. (1994) [14], on the other hand, noted that an ET ≤7 mm reliably predicted normal endometrium in periand postmenopausal women. This is in keeping with our observation that the majority of the women with normal histology had ET ≤8 mm. However, the specificity in that report was only 46%, which again points out the challenge in using a single threshold value for ET across populations. These variations indicate how difficult it is to have a single universal threshold for ET that will predict endometrial pathology, particularly in perimenopausal women because of fluctuating levels of hormones that influence endometrial thickness (Bakose et al., 1993) [15].

Advanced age and obesity were also found to be significant risk factors for abnormal endometrium in our study, with an approximately fourfold increased risk in women >45 years of age, and a 3.5-fold increased risk in obese women. These findings are supported by other studies, including that of Mayuri et al. (2014) [12], where it was similarly reported that abnormal endometrium was seen more frequently in older women. Obesity has traditionally been viewed as a key contributor to endometrial pathology, due to peripheral aromatization of androgen into estrogen, resulting in unopposed endometrial stimulation (Bergstrom et al., 2001; Calle & Kaaks, 2004; Amant et al., 2005) [16-18]. Our finding that parity did not have a significant impact on endometrial pathology contrasts with other studies suggesting that nulliparity is itself a risk factor (Beining et al., 2008) [19] and perhaps reflects the influence of stronger factors like age and BMI in our cohort.

The role of resistance index and pulsatility index in Doppler ultrasonography was investigated as potential non-invasive predictors of endometrial abnormalities. While mean RI and PI were marginally lower in the abnormal group, these differences did not reach statistical significance, indicating little diagnostic benefit in our population. This agrees with Mine et al. (2007), who reported moderate sensitivity and specificity of Doppler indices in endometrial assessment, but is contrasted by Sawicki et al. (2002), who described low-impedance, high-velocity flow as being commonly found in endometrial carcinoma. Our findings may result from the inclusion of a wide range of etiologies for AUB, including polyps and hyperplasia, which might not significantly alter endometrial vascular resistance. In the future, power Doppler and three-dimensional ultrasonography have shown promise in the differentiation of malignant from benign endometrium, as demonstrated by Sharkawy et al. (2016) and Zhang et al. (2019), although these techniques were outside the purview of our study.

Histopathological distribution in our cohort revealed that 70% had normal proliferative or secretory endometrium, while the remaining 30% had polyps, hyperplasia, or adenocarcinoma. This agrees with previous observations among Indian women with AUB (Mayuri et al., 2014; Muzaffar et al., 2005) [12,22] and reveals similar trends of increasing prevalence of abnormal endometrium with age and obesity reported in European and American populations (Bergstrom et al. 2001; Calle & Kaaks, 2004) [16,17]. Our study further reinforces that an ET above 10.5 mm has a strong correlation with abnormal histology since 77.7% women with abnormal endometrium exceeded this threshold, thus justifying the use of TVS as a triage tool to identify women requiring endometrial sampling.

Overall, our findings confirm that increase in endometrial thickness, advanced age, and obesity are significant predictors of abnormal endometrium in women with AUB. Indeed, the optimal cut-off value of 10.5 mm in the current study is highly sensitive

and specific, corroborating other international studies, though variations also depend on menopausal status and different population characteristics. Doppler indices did not provide added diagnostic advantage, which accords with the knowledge that ET remains the foremost non-invasive predictor of endometrial pathology. Such results substantiate the current guidelines recommending endometrial evaluation in high-risk women and provide important evidence for establishing population-specific thresholds of ET.

Conclusion

This study proved that TVS for measuring endometrial thickness is a reliable, noninvasive tool for predicting histopathological abnormality in women presenting with abnormal uterine bleeding. Increased endometrial thickness was strongly associated with abnormal histopathological findings, and a cut-off value differentiated normal from abnormal endometrium with highly sensitive, specific, and overall diagnostic accuracy. Advanced age and obesity further emerged as significant predictors for endometrial pathology. These factors suggest that patient characteristics must be considered along with TVS measurement when making clinical decisions. These findings justify the role of endometrial thickness assessment as a practical screening modality to indicate further invasive assessment.

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