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# ROLE OF TRANSVAGINAL SONOGRAPHY IN RISK STRATIFICATION OF POSTMENOPAUSAL BLEEDING: CORRELATION WITH HISTOPATHOLOGY

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ABSTRACT

**Background:** Postmenopausal bleeding is a significant clinical concern due to its association with endometrial pathology, including malignancy. Transvaginal sonography serves as a non-invasive tool for assessing endometrial thickness and guiding further management.

**Materials and Methods:** This cross-sectional study included 226 postmenopausal women presenting with bleeding at a tertiary care center. All participants underwent transvaginal sonography for measurement of endometrial thickness, followed by histopathological evaluation where indicated. Diagnostic performance of different endometrial thickness cut-offs was assessed using statistical analysis and ROC curve.

**Results:** The mean endometrial thickness was 8.6 ± 4.3 mm. Benign lesions were most common (74.3%), with endometrial atrophy predominating (46.0%), while premalignant and malignant lesions accounted for 16.8% and 8.9%, respectively. A significant association was observed between increasing endometrial thickness and pathological severity ($p < 0.001$). At a cut-off of ≥4 mm, sensitivity and negative predictive value were 100%, whereas a threshold of 8.5 mm improved specificity (78.0%) with an AUC of 0.89.

**Conclusion:** Transvaginal sonography is a reliable first-line modality in postmenopausal bleeding. Endometrial thickness effectively stratifies risk, with lower thresholds excluding malignancy and higher thresholds improving diagnostic precision.

**Keywords:** Postmenopausal bleeding, Endometrial thickness, Transvaginal sonography, Endometrial carcinoma, ROC curve.

## INTRODUCTION

Postmenopausal bleeding (PMB) is a clinically significant symptom that warrants prompt evaluation, as it may be the earliest manifestation of underlying endometrial pathology, including malignancy. It is defined as any uterine bleeding occurring after 12 months of amenorrhea following menopause and accounts for approximately 5–10% of gynecological outpatient visits among postmenopausal women.[1] Although the majority of cases are attributed to benign conditions such as endometrial atrophy (60–80%), the risk of endometrial carcinoma ranges between 5% and 15%, making timely and accurate assessment essential.[2,3]

Endometrial carcinoma is the most common gynecological malignancy in developed countries and is increasingly reported in developing regions, including India.[4] The incidence of endometrial cancer in women presenting with PMB rises with advancing age, obesity, unopposed estrogen exposure, diabetes mellitus, and hypertension.[5] Early detection is critical, as the prognosis is highly favorable when diagnosed at an early stage, with 5-year survival rates exceeding 90% in localized disease.[6]

Traditionally, evaluation of PMB involved invasive procedures such as dilatation and curettage (D&C) or hysteroscopy with biopsy. However, these methods are associated with discomfort, procedural risks, and increased healthcare costs.[7] In recent years, transvaginal sonography (TVS) has emerged as a first-line, non-invasive, and cost-effective diagnostic modality for assessing the endometrium in

postmenopausal women.[8] TVS allows accurate measurement of endometrial thickness (ET), which serves as an important surrogate marker for endometrial pathology.[8]

Literature have demonstrated that endometrial thickness measured by TVS is a reliable predictor of endometrial abnormalities.[9] An endometrial thickness of ≤4 mm is generally considered reassuring, with a negative predictive value exceeding 99% for excluding endometrial carcinoma.[9] Conversely, increasing endometrial thickness is associated with a higher likelihood of hyperplasia or malignancy, necessitating further histopathological evaluation.[10] Despite this, there remains variability in optimal cut-off values across different populations and clinical settings.

In resource-limited settings, the use of TVS as a screening and triaging tool for PMB can significantly reduce unnecessary invasive procedures while ensuring early detection of clinically significant pathology. However, population-specific data regarding the diagnostic utility and threshold values of endometrial thickness are still limited. Therefore, the present study was aimed to evaluate endometrial thickness by transvaginal sonography in postmenopausal women presenting with bleeding and to assess its role as a diagnostic tool in identifying underlying endometrial pathology.

## MATERIALS AND METHODS

**Study Design and Setting:** This cross-sectional observational study was conducted in the Department of Obstetrics and Gynecology at a tertiary care teaching hospital over a period of 2 years between March 2023 to February 2025. The study aimed to evaluate endometrial thickness using transvaginal sonography in postmenopausal women presenting with bleeding. Approval was obtained from the Institutional Ethics Committee prior to initiation of the study, and all procedures were carried out in accordance with ethical standards. Written informed consent was obtained from all participants before enrollment.

**Study Population:** The study included postmenopausal women aged ≥45 years presenting with complaints of vaginal bleeding after cessation of menstruation for at least 12 months. Patients were recruited consecutively during the study period. Women with a history of hormone replacement therapy, tamoxifen intake, known coagulation disorders, previously diagnosed endometrial carcinoma, or prior hysterectomy were excluded. Additionally, patients with an identifiable non-uterine source of bleeding on clinical examination or those unwilling to participate were not included in the study.

**Clinical Evaluation:** All participants underwent a detailed clinical assessment, including documentation of demographic variables such as age, parity, and body mass index, along with relevant medical history including diabetes mellitus and hypertension. A comprehensive general physical and systemic examination was performed. Gynecological evaluation, including per speculum and bimanual examination, was carried out to exclude local causes of bleeding from the cervix, vagina, or vulva.

**Transvaginal Sonography Assessment:** Transvaginal sonography was performed for all patients using a high-frequency endovaginal probe (5–9 MHz) by an experienced sonologist. The examination was conducted with the patient in the lithotomy position after ensuring an empty bladder. Endometrial thickness was measured in the mid-sagittal plane of the uterus as the maximum double-layer thickness between the two endometrial–myometrial interfaces. In cases where intracavitary fluid was present, each endometrial layer was measured separately and summed. Additional findings such as endometrial echotexture, uniformity, presence of focal lesions (polyps, submucosal fibroids), and adnexal abnormalities were also recorded.

**Histopathological Evaluation:** Patients with increased endometrial thickness (≥4 mm) or suspicious sonographic features underwent endometrial sampling by pipelle biopsy, dilatation and curettage, or hysteroscopy-guided biopsy depending on clinical indication. The obtained endometrial tissue samples were sent for histopathological examination, which was considered the gold standard for diagnosis. Histopathological findings were categorized into benign (atrophy, proliferative/secretory endometrium), premalignant (endometrial hyperplasia), and malignant lesions (endometrial carcinoma).

**Outcome Measures:** The primary outcome was to assess the distribution of endometrial thickness in postmenopausal women with bleeding and its correlation with histopathological findings. Secondary outcomes included evaluation of the diagnostic performance of transvaginal sonography in detecting endometrial pathology and determination of an optimal endometrial thickness cut-off value for predicting significant lesions.

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using SPSS version 20.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The association between endometrial thickness and histopathological outcomes was analyzed using ANOVA for continuous variables and chi-square test or Fisher's exact test for categorical variables. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal cut-off value of endometrial thickness for predicting significant endometrial pathology. A p-value of $<0.05$ was considered statistically significant.

## RESULTS

The mean age of the study population was 59.8 ± 7.6 years, with the majority of women in the 55–64 years age group (42.5%), followed by ≥65 years (31.8%) and 45–54 years (25.7%). Most participants were multiparous (85.0%), while nulliparous women constituted 15.0%. The mean BMI was 26.4 ± 3.8 kg/m², with a predominance of overweight (47.8%) and obese (20.3%) individuals. Comorbidities were common, with hypertension (45.1%) being more prevalent than diabetes mellitus (34.5%), and 23.0% having both conditions. The mean duration since menopause was 9.1 ± 5.3 years, with the majority between 5–10 years (40.7%) [Table 1].

**Table 1: Baseline Demographic and Clinical Characteristics of Study Population (n = 226).**

| Variable | Frequency (%)/mean ± SD |
|---|---|
| Age | 59.8 ± 7.6 |
| 45–54 years | 58 (25.7%) |
| 55–64 years | 96 (42.5%) |
| ≥65 years | 72 (31.8%) |
| Parity | |
| Nulliparous | 34 (15.0%) |
| Multiparous (≥1) | 192 (85.0%) |
| BMI (kg/m²) | 26.4 ± 3.8 |
| BMI category | |
| <25 (Normal) | 72 (31.9%) |
| 25–29.9 (Overweight) | 108 (47.8%) |
| ≥30 (Obese) | 46 (20.3%) |
| Comorbidities | |
| Diabetes mellitus | 78 (34.5%) |
| Hypertension | 102 (45.1%) |
| Both DM + HTN | 52 (23.0%) |
| Duration since menopause (years) | 9.1 ± 5.3 |
| Duration since menopause | |
| <5 years | 64 (28.3%) |
| 5–10 years | 92 (40.7%) |
| >10 years | 70 (31.0%) |

BMI: Body Mass Index; DM: Diabetes Mellitus; HTN: Hypertension.

The mean endometrial thickness was 8.6 ± 4.3 mm. Most women had ET between 5–10 mm (42.5%), followed by ≤4 mm (30.1%) and >10 mm (27.4%). On sonographic assessment, homogeneous endometrial echotexture was observed in 54.9% of cases, while 45.1% demonstrated heterogeneity. Focal lesions included endometrial polyps (12.4%) and submucosal fibroids (9.7%). Intracavitary fluid was present in 8.0% of patients, and adnexal pathology was identified in 6.2% [Table 2].

**Table 2: Transvaginal Sonography (TVS) Findings in Postmenopausal Women with Bleeding (n = 226).**

| Parameter | Frequency (%)/mean ± SD |
|---|---|
| Endometrial thickness (mm) | 8.6 ± 4.3 |
| Endometrial thickness | |
| ≤4 mm | 68 (30.1%) |
| 5–10 mm | 96 (42.5%) |
| >10 mm | 62 (27.4%) |
| Endometrial echotexture | |
| Homogeneous | 124 (54.9%) |
| Heterogeneous | 102 (45.1%) |
| Focal lesions | |
| Endometrial polyp | 28 (12.4%) |
| Submucosal fibroid | 22 (9.7%) |
| Intracavitary fluid | 18 (8.0%) |
| Adnexal pathology | 14 (6.2%) |

ET: Endometrial Thickness.

Histopathological evaluation revealed that benign lesions predominated (74.3%), with endometrial atrophy being the most common finding (46.0%), followed by proliferative/secretory endometrium (16.8%) and endometrial polyps (11.5%). Premalignant lesions accounted for 16.8%, comprising hyperplasia without atypia (12.4%) and atypical hyperplasia (4.4%). Malignant lesions (endometrial carcinoma) were observed in 8.9% of cases [Table 3].

**Table 3: Histopathological Distribution of Endometrial Lesions (n = 226).**

| Diagnosis | Frequency (%) |
|---|---|
| Benign (n=168) | |
| Endometrial atrophy | 104 (46.0%) |
| Proliferative/secretory endometrium | 38 (16.8%) |
| Endometrial polyp | 26 (11.5%) |
| Premalignant (n=38) | |

| | |
|---|---|
| Endometrial hyperplasia (without atypia) | 28 (12.4%) |
| Atypical hyperplasia | 10 (4.4%) |
| Malignant (n=20) | |
| Endometrial carcinoma | 20 (8.9%) |

A statistically significant association was observed between endometrial thickness and histopathological diagnosis ($p < 0.001$). Among women with ET ≤4 mm, nearly all cases were benign (97.1%), with no malignant lesions detected. In the 5–10 mm group, benign lesions remained predominant (83.3%), though premalignant (14.6%) and malignant (2.1%) lesions were also observed. In contrast, ET >10 mm showed a marked increase in premalignant (35.5%) and malignant lesions (29.0%), with only 35.5% benign cases. Mean ET increased progressively from 6.2 ± 2.8 mm in benign, to 9.8 ± 3.4 mm in premalignant, and 13.6 ± 4.1 mm in malignant lesions, which was statistically significant ($p < 0.001$) [Table 4].

**Table 4: Association Between Endometrial Thickness and Histopathological Findings.**

| Endometrial Thickness | Benign (n=168) | Premalignant (n=38) | Malignant (n=20) | p-value |
|---|---|---|---|---|
| | Frequency (%)/mean ± SD | | | |
| ≤4 mm (n=68) | 66 (97.1%) | 2 (2.9%) | 0 (0%) | <0.001 |
| 5–10 mm (n=96) | 80 (83.3%) | 14 (14.6%) | 2 (2.1%) | |
| >10 mm (n=62) | 22 (35.5%) | 22 (35.5%) | 18 (29.0%) | |
| ET (mm) | 6.2 ± 2.8 | 9.8 ± 3.4 | 13.6 ± 4.1 | <0.001 |

ET: Endometrial Thickness.

At a cut-off value of ET ≥4 mm, TVS demonstrated 100% sensitivity and 100% NPV, effectively ruling out significant pathology when ET was <4 mm. However, specificity was low (39.3%) with a PPV of 43.8%. Using a higher cut-off of ET ≥8.5 mm, sensitivity decreased to 84.5%, but specificity improved substantially to 78.0%, with corresponding PPV and NPV of 57.0% and 93.6%, respectively. This indicates a better balance between sensitivity and specificity at the higher threshold [Table 5].

**Table 5: Diagnostic Performance of Transvaginal Sonography at Different Endometrial Thickness Cut-offs.**

| Cut-off | Disease Present (n=58) | Disease Absent (n=168) |
|---|---|---|
| TVS (ET ≥4 mm) | | |
| Positive (≥4 mm) (n=160) | 58 (TP) | 102 (FP) |
| Negative (<4 mm) (n=66) | 0 (FN) | 66 (TN) |
| Sensitivity: 100.0%; Specificity: 39.3%, PPV: 43.8%; NPV: 100.0% | | |
| TVS (ET ≥8.5 mm) | | |
| Positive (≥8.5 mm) (n=86) | 49 (TP) | 37 (FP) |
| Negative (<8.5 mm) (n=140) | 9 (FN) | 131 (TN) |
| Sensitivity: 84.5%; Specificity: 78.0%, PPV: 57.0%; NPV: 93.6% | | |

TVS: Transvaginal Sonography; ET: Endometrial Thickness; TP: True Positive; FP: False Positive; TN: True Negative; FN: False Negative; PPV: Positive Predictive Value; NPV: Negative Predictive Value.

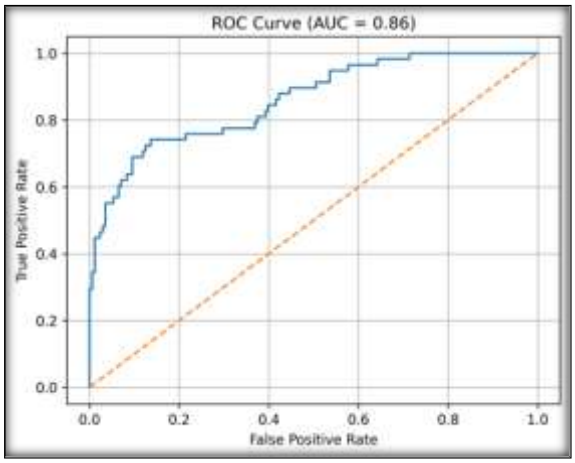


**Figure 1: Receiver Operating Characteristic (ROC) Curve for Endometrial Thickness in Predicting Premalignant and Malignant Lesions**

AUC: Area Under Curve; CI: Confidence Interval.

Receiver operating characteristic (ROC) curve analysis demonstrated good diagnostic performance of endometrial thickness in predicting premalignant and malignant lesions, with an area under the curve (AUC) of 0.89 (95% CI: 0.84–0.93, $p < 0.001$). This indicates a high discriminative ability of transvaginal sonography in identifying clinically significant endometrial pathology [Figure 1].

## DISCUSSION

The present study evaluated the diagnostic utility of endometrial thickness (ET) measured by transvaginal sonography (TVS) in postmenopausal women presenting with bleeding and demonstrated a strong association between increasing ET and the likelihood of premalignant and malignant endometrial pathology. The mean age of the study population (59.8 ± 7.6 years) and the predominance of multiparous women (85%) are consistent with prior Indian studies by Talwar et al., and Paul et al., which report peak incidence of postmenopausal bleeding (PMB) in the sixth decade of life.[11,12] The high

prevalence of metabolic comorbidities such as hypertension (45.1%) and diabetes mellitus (34.5%) in our cohort further supports their established role as risk factors for endometrial hyperplasia and carcinoma through mechanisms involving chronic inflammation, hyperinsulinemia, and unopposed estrogen exposure.[13,14]

Histopathologically, benign lesions predominated (74.3%), with endometrial atrophy (46.0%) being the most common finding, aligning with previous studies by Hemalatha et al., Husain et al., and Vichitra et al., where atrophy accounts for 60–80% of PMB cases.[13-15] However, the proportion of endometrial carcinoma (8.9%) observed in this study is comparable to reported rates ranging from 5–15%, reinforcing the need for prompt evaluation of PMB I the studies by Husain et al., and Vichitra et al.[15,16] The presence of premalignant lesions (16.8%) also highlights the importance of early detection, as these conditions represent a continuum in endometrial carcinogenesis.

A key finding of this study is the statistically significant association between ET and histopathological outcomes ($p < 0.001$). Women with ET ≤4 mm were almost exclusively associated with benign pathology (97.1%), with no cases of malignancy, corroborating the widely accepted threshold of 4 mm as a safe cut-off for excluding endometrial carcinoma.[17] This is consistent with studies by Saravade et al., and Veena et al., which report a negative predictive value exceeding 99% for ET ≤4 mm.[17,18] In contrast, ET >10 mm was strongly associated with premalignant (35.5%) and malignant lesions (29.0%), demonstrating a clear risk gradient. The progressive increase in mean ET from benign (6.2 ± 2.8 mm) to premalignant (9.8 ± 3.4 mm) and malignant groups (13.6 ± 4.1 mm) supports the biological plausibility that increasing endometrial proliferation and architectural disorganization contribute to greater sonographic thickness.[19,20]

The diagnostic performance analysis further strengthens the clinical utility of TVS. At a cut-off of ≥4 mm, TVS demonstrated 100% sensitivity and NPV, making it an excellent screening tool to rule out significant pathology. However, the low specificity (39.3%) reflects a high false-positive rate, which may lead to unnecessary invasive procedures. This limitation has been highlighted in previous studies by Vijaysingh et al., Kumari et al., emphasizing that while a low ET effectively excludes malignancy, it lacks specificity for confirming disease.[21,22] Importantly, our ROC curve analysis identified an optimal cut-off of 8.5 mm, which provided a better balance between sensitivity (84.5%) and specificity (78.0%), with an AUC of 0.89, indicating excellent diagnostic accuracy. These findings are comparable to other studies by Saha et al., and Shah et al., reporting AUC values between 0.80 and 0.90 and suggesting higher ET thresholds (8–10 mm) for improved specificity in detecting significant pathology.[23,24]

Additionally, sonographic features such as heterogeneous echotexture and intracavitary fluid were more frequently associated with premalignant and malignant conditions, supporting their role as adjunctive markers of endometrial pathology.[25,26] The increased heterogeneity observed in malignant cases may reflect underlying structural irregularity, necrosis, and increased vascularity, while intracavitary fluid may indicate obstruction or tumor-related secretions.[27-29]

**Limitations:** This study has certain limitations. Being a single-center cross-sectional study, the findings may have limited generalizability. Selection bias cannot be excluded, as only symptomatic women with postmenopausal bleeding were included. Histopathological confirmation was not uniform for all patients with thin endometrium. Additionally, interobserver variability in sonographic assessment and lack of long-term follow-up may have influenced diagnostic accuracy and outcome interpretation.

## CONCLUSION

The present study demonstrates that transvaginal sonography is an effective, non-invasive modality for evaluating postmenopausal bleeding. Endometrial thickness shows a strong correlation with histopathological outcomes, with a threshold of ≤4 mm reliably excluding malignancy due to its high sensitivity and negative predictive value. However, higher cut-off values such as 8.5 mm offer improved specificity and overall diagnostic accuracy. The progressive increase in endometrial thickness from benign to malignant conditions underscores its clinical relevance. Incorporating endometrial thickness measurement with additional sonographic features can optimize patient stratification, minimize unnecessary invasive procedures, and facilitate early detection of significant endometrial pathology, particularly in resource-limited settings.

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