

Original Research

Application of Vaginal Ultrasound and Hysteroscopy in the Diagnosis of Perimenopausal Endometrial Lesions

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Abstract

Background: This study aimed to investigate the utility of transvaginal ultrasound and hysteroscopy in diagnosing abnormal uterine bleeding in peri-menopausal women. **Methods:** Between September 2021 and March 2023, 176 women presenting with abnormal uterine bleeding at the Second Affiliated Hospital of Xinjiang Medical University were subjected to both hysteroscopy and transvaginal ultrasound examinations. **Results:** There was a significant discrepancy between the pathological diagnoses and the findings from transvaginal ultrasound ($p < 0.05$), with a Kappa coefficient of 0.475, indicating moderate agreement. Similarly, a significant difference was observed between the results of pathological diagnosis and those obtained via hysteroscopy ($p < 0.05$), with a Kappa coefficient of 0.669, suggesting substantial agreement. The combined diagnostic approach yielded a Kappa value of 0.784, demonstrating a better consistency and indicating superior diagnostic efficacy. In diagnosing peri-menopausal abnormal uterine bleeding, transvaginal ultrasound exhibited a sensitivity of 89.7%, specificity of 66.7%, and a negative predictive value of 46.7%. Hysteroscopy showed higher sensitivity and specificity at 94.8% and 76.2% respectively, but a relatively low negative predictive value of 66.7%. The combined diagnostic approach further improved the sensitivity and specificity to 97.4% and 81.0% respectively, with a negative predictive value of 81.0%, surpassing those of the individual methods. For the etiological diagnosis of abnormal uterine bleeding (AUB) caused by endometrial polyps, hysteroscopy achieved a concordance rate of 93.3%, significantly outperforming transvaginal ultrasound, which had a rate of 77.3% ($\chi^2 = 7.670$), thus demonstrating higher detection efficiency. **Conclusions:** Transvaginal ultrasound and hysteroscopy are valuable diagnostic tools in the etiological assessment of peri-menopausal AUB. Transvaginal ultrasound, being safe and cost-effective, is preferable for initial etiological screening of AUB, though it carries the risk of underdiagnosis and misdiagnosis. Despite the higher cost and reduced convenience of hysteroscopy, its combination with pathological examination significantly enhances the detection rates of cancerous and precancerous lesions. Consequently, the integration of transvaginal ultrasound with hysteroscopy is recommended for the comprehensive diagnostic evaluation of endometrial lesions in peri-menopausal women with AUB, facilitating early diagnosis and treatment.

Keywords: uterus; AUB; hysteroscopy; transvaginal ultrasound; peri-menopausal abnormal uterine bleeding

1. Introduction

Perimenopause represents a pivotal transition in a woman's life, marked by a natural shift from regular menstrual cycles to anovulatory cycles, characterised by irregular and often excessive menstruation, culminating in permanent infertility [1]. This phase typically commences 2 to 8 years prior to menopause and concludes one year thereafter [2]. Abnormal uterine bleeding (AUB) is a prevalent gynaecological condition among peri-menopausal women. During this period, ovarian function declines gradually, leading to a decrease in estradiol levels, which may result in abnormal uterine bleeding. The prevalence of AUB ranges from 10% to 30% among women of childbearing age, escalating to up to 90% among peri-menopausal women. Although AUB is predominantly attributed to benign lesions, it can also emanate from malignant lesions, such as atypical endometrial hyperplasia or endometrial carcinoma [3]. In 2011, the International Federation of Gynecology and Ob-

stetrics (FIGO) introduced a novel classification system for AUB, subsequently endorsed by the American Congress of Obstetrics and Gynecology (ACOG) in 2012. This system, referred to by the acronym PALM-COEIN (endometrial polyp, adenomyosis, leiomyoma, malignancy and hyperplasia, coagulopathy, ovulatory dysfunction, endometrial, iatrogenic, and not yet classified), categorises AUB based on its suspected aetiology: polyp, adenomyosis, leiomyoma, malignancy and hyperplasia, coagulopathy, ovulatory dysfunction, endometrial, iatrogenic, and not yet classified [4]. Consequently, peri-menopausal AUB can significantly impair the physical and mental health of affected women. Therefore, early detection and diagnosis are paramount for the management of endometrial malignancies. Currently, the primary clinical diagnostic techniques include transvaginal ultrasound, hysteroscopy, and diagnostic uterine curettage, with hysteroscopy and transvaginal ultrasound being the most frequently utilised ancillary exami-



nation methods [5]. Hysteroscopy is regarded as the gold standard in the diagnosis and treatment of female endometrial lesions [6]. Transvaginal ultrasound plays a crucial role in the diagnosis of AUB, offering a comprehensive assessment of the uterus and its surrounding structures. Nevertheless, the accuracy of transvaginal ultrasound in diagnosing uterine lesions is suboptimal, with inconsistent diagnostic criteria and repeatability. In contrast, hysteroscopy proves more efficacious than transvaginal ultrasound in diagnosing endometrial diseases, albeit with limitations such as high costs, reduced convenience, and lower patient tolerance [7]. The aim of this study was to evaluate the efficacy of transvaginal ultrasound and hysteroscopy in the etiological diagnosis of peri-menopausal AUB, thereby providing a scientific foundation for the early diagnosis and treatment of perimenopausal abnormal uterine haemorrhage.

2. Materials and Methods

2.1 Clinical Data

Between September 2021 and March 2023, a retrospective study was conducted at the Second Affiliated Hospital of Xinjiang Medical University, involving 176 perimenopausal women experiencing abnormal uterine bleeding. Inclusion criteria included: ① women presenting with abnormal uterine bleeding; ② those with definitive pathological diagnosis results; ③ perimenopausal women aged between 40–59 years; ④ those who underwent transvaginal ultrasound and hysteroscopy. Exclusion criteria encompassed: ① unknown pathological diagnosis; ② women not in the peri-menopausal period; ③ non-uterine sources of bleeding; ④ absence of transvaginal ultrasonography or hysteroscopy.

2.2 Inspection Method

2.2.1 Transvaginal Ultrasound (TVU)

Performed by an ultrasound specialist with over five years of experience in the ultrasound diagnosis department of the Second Affiliated Hospital of Xinjiang Medical University, Doppler colour ultrasound was utilised individually. The probe frequency ranged from 5.0–9.0 MHz. Comprehensive examination techniques included oblique, cross-sectional, and longitudinal scans, conducted after gently inserting the transvaginal ultrasound probe into the vaginal fornix or onto the cervical surface. The assessment focused on the uterus's shape, intrauterine cavity echoes, lesion location, endometrial thickness measurement, and the presence of abnormal lesions like polyps, hyperplasia, cancer, etc. Additionally, the examination sought to identify abnormalities in the bilateral adnexa and pelvic cavity. TVU is pivotal in diagnosing structural causes of AUB (PALM category) and evaluating nonstructural causes such as ovulatory dysfunction [8]. The classification of intracavitary fluid, structure, echogenicity, border, and the endometrial–myometrial boundary was based on the International Endometrial Tumor Analysis (IETA) System, util-

ising B-mode ultrasound [9]. During evaluation, clinicians ensured the uterus occupied two-thirds of the screen for optimal clarity [10,11]. Vascular patterns identified included: scattered vessel pattern: indicative of endometrial hyperplasia, characterised by widespread vasculature within the endometrium. Multiple Vascular Pattern: associated with endometrial cancer, featuring multiple vessels at the endometrium and the myometrial–endometrial interface due to angiogenic proliferation within and around tumour tissue. Pedicle Vascular Pattern: a single vessel penetrating the endometrium. Circular Vascular Pattern: increased peripheral vascularity around the tumour, typical of uterine fibroids [9]. On TVU, polyps may manifest as non-specific endometrial thickening or focal masses within the endometrial cavity, potentially matching the surrounding endometrium in echogenicity with smooth borders, though they may also appear heterogeneous. Endometrial polyps are often characterised by a dominant central feeder vessel, visible via color flow Doppler techniques. While there are no definitive imaging criteria for adenomyosis diagnosis, the most specific indication is subendometrial echogenic linear striations. An ill-defined endometrial/myometrial border also suggests adenomyosis. Leiomyomas are distinguished by a pseudocapsule providing a well-defined border on ultrasound. They often absorb ultrasound beams, resulting in a shadowing effect behind the myoma, sometimes referred to as a “Venetian-blind effect” [12].

2.2.2 Hysteroscopy

Gynaecologists from the Second Affiliated Hospital of Xinjiang Medical University, boasting over a decade of extensive clinical experience, performed hysteroscopy (Olympus Corp., Shinjuku, Tokyo, Japan) under anaesthesia. The flow rate and pressure of the liquid distension medium were regulated to 200–400 mL/min and 100–150 mmHg, respectively, utilising 0.9% sodium chloride solution for cervical canal dilation. Following cervical canal dilation, the hysteroscope was connected to observe the endometrium's thickness and colour, the openings of the bilateral fallopian tubes, the angles of the uterus, the shape of the uterine cavity, the cervical canal, and to examine the size of intrauterine lesions and the distribution of blood vessels. Electrosurgical resection was performed on the abnormal areas, and diagnostic curettage of the uterine cavity wall was conducted to obtain tissue samples from the endometrium and suspicious lesions within the uterine cavity for pathological examination. Under hysteroscopic examination, most submucous fibroids manifest as spherical masses protruding into the uterine cavity. Diagnostic hysteroscopy cannot conclusively diagnose adenomyosis due to its limitation to the superficial endometrial layer [13]. However, typical hysteroscopic findings may include: (i) an irregular endometrium with tiny surface openings; (ii) pronounced hypervascularisation; (iii) an endometrial “strawberry” pattern; (iv) a fibrous cystic appearance of in-

trauterine lesions following 3–5 episodes of intramyometrial haemorrhage; (v) haemorrhagic cystic lesions presenting a dark blue or chocolate brown appearance [14]. Uterine polyps are characterised as individualised endometrial outgrowths that can emerge throughout the uterine cavity, consisting variably of stroma, glands, and blood vessels, with their proportional composition influencing their hysteroscopic appearance [15]. In cases of endometrial hyperplasia, the hysteroscopic view may reveal local or diffuse thickening of the endometrium, occasionally with single or multiple protrusions, which could be honeycombed or mesh-like. If the appearance is greyish white or yellow, or if there is a heterogeneous distribution of large blood vessels, atypical endometrial hyperplasia or endometrial cancer should be strongly suspected [16].

2.2.3 Pathological Examination

Tissue samples were fixed in 10% formaldehyde, embedded in paraffin, and subjected to routine sectioning and staining. An Olympus optical microscope (Olympus Corp., Shinjuku, Tokyo, Japan) was used for examination. The final pathological diagnosis served as the gold standard.

2.2.4 Statistics

Statistical analysis was conducted using SPSS 26.0 (IBM Corp., Armonk, NY, USA). The rates of count data were expressed in percentages (%). The Chi-square test was employed to analyse the diagnostic efficiency differences between methods. Kappa coefficients were used to assess the consistency of analysis, with <0.45 indicating poor agreement, $0.45–0.6$ moderate agreement, $0.6–0.85$ good agreement, and >0.85 excellent agreement. The positive predictive value, negative predictive value, specificity, and sensitivity of different methods for diagnosing peri-menopausal AUB were calculated. The concordance rates between the two examination methods were calculated and compared according to the aetiology based on the pathological diagnosis. A statistically significant difference was indicated by ($p < 0.05$). Based on research and design, the Kappa coefficients of each diagnosis method and gold standard (pathology) were selected as the index of sample size estimation. Consult the literature in the early stage, the Kappa coefficient of hysteroscopy and gold standard (pathology) is higher, about 0.84 (K1). In general, K000.70 can be considered to be highly consistent with the gold standard, setting parameters: $\alpha = 0.05$, grip (test efficiency) $1-\beta = 0.80$, bilateral test, p (frequencies): 0.5. Sample size estimation by PASS15 software (NCSS Corp., Kaysville, UT, USA), set according to the above parameters, the result sample size is N (number) = 176.

3. Results

3.1 Basic Patient Information ($\bar{x} \pm s$)

According to the study flowchart (Fig. 1), collected the patient information and screened the patients eligible

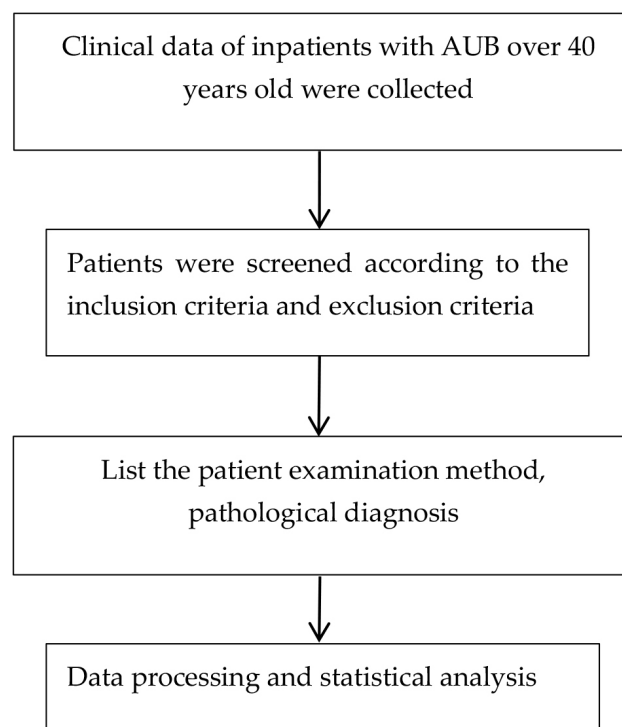


Fig. 1. Study flowchart. AUB, abnormal uterine bleeding.

for the study. Based on clinical data of 176 patients, we were collected for their age, body mass index (BMI), age at menarche, pregnancy history, and accompanying symptoms. The average age of the 176 patients in the study was 47.26, average body mass index (BMI) 25.21. All the information met the inclusion criteria of this study. The average age of menarche 13.74, more than two pregnancies on average (Table 1).

3.2 Consistency of Pathological Diagnosis and Different Methods in Diagnosis of Peri-menopausal AUB

The findings of this study revealed a significant discrepancy between the pathological diagnosis and the outcomes obtained from transvaginal ultrasound ($p < 0.05$), with a Kappa coefficient of 0.475 indicating moderate consistency. A marked difference was also noted between the pathological diagnosis and the results yielded by hysteroscopy ($p < 0.05$), where the Kappa value reached 0.669, suggesting substantial consistency. The combined diagnostic approach achieved a Kappa value of 0.784, enhancing the consistency effect and demonstrating that the integration of both diagnostic methods is more efficacious, as delineated in Table 2.

3.3 Diagnostic Efficacy of Different Methods in Peri-menopausal AUB

In the context of diagnosing peri-menopausal AUB, transvaginal ultrasound demonstrated a sensitivity of 89.7%, a specificity of 66.7%, and a negative predictive value of 46.7%. The diagnostic sensitivity and specificity

Table 1. Basic patient information (n = 176)

Patient (n)	Age (years)	BMI (kg/m ²)	Age at menarche (years)	Number of pregnancies (n)	Number of deliveries (n)	A history of abortion (n)		Hypertension (n)		Glycuresis (n)	
						With	Without	With	Without	With	Without
176	47.26 ± 4.75	25.21 ± 2.51	13.74 ± 1.59	2.58 ± 1.42	1.42 ± 0.75	36	140	20	156	6	170

BMI, body mass index.

Table 2. Consistency of different methods in the diagnosis of peri-menopausal abnormal uterine (n = 176) bleeding and pathological diagnosis [case (%)].

Grouping	Pathological diagnosis		χ^2	p	OR (95% CI)	Kappa
	Pathological	Physiological				
Transvaginal ultrasound						
Abnormal	139 (95.2)	7 (4.8)	41.523	0.000	17.375 (6.114–49.377)	0.475
Normal	16 (53.3)	14 (46.7)				
Hysteroscope						
Abnormal	147 (96.7)	5 (3.3)	79.229	0.000	58.800 (17.174–201.315)	0.669
Normal	8 (33.3)	16 (66.7)				
Two kinds of combination*						
Abnormal	151 (97.4)	4 (2.6)	108.101	0.000	160.438 (36.748–700.449)	0.784
Normal	4 (19.0)	17 (81.0)				

Note: * indicates transvaginal ultrasound combined with hysteroscopy. OR, odds ratio; 95% CI, 95% confidence interval.

of hysteroscopy were superior, at 94.8% and 76.2% respectively, although the negative predictive value remained relatively low at 66.7%. The combined diagnostic methodology exhibited enhanced sensitivity, specificity, and negative predictive value at 97.4%, 81.0%, and 81.0% respectively, surpassing the performance of either transvaginal ultrasound or hysteroscopy when used independently, as illustrated in Table 3.

3.4 The Coincidence Rate of Different Methods in the Diagnosis of Peri-menopausal AUB

Concerning the etiological diagnosis of AUB attributable to endometrial polyps, hysteroscopy achieved a concordance rate of 93.3%, significantly exceeding that of transvaginal ultrasound, which stood at 77.3%. This difference was statistically significant ($\chi^2 = 7.670$), indicating a higher detection efficiency for hysteroscopy. In the etiological assessment of AUB resulting from malignant transformation of the endometrium, atypical hyperplasia, benign hyperplasia, leiomyoma, adenomyosis, normal endometrium, and other factors, no statistically significant difference was observed between the concordance rates of hysteroscopy and transvaginal ultrasound ($p > 0.05$), as presented in Table 4.

4. Discussion

During the peri-menopausal period, ovarian function diminishes progressively, leading to imbalances in estrogen and progesterone levels. This hormonal disruption can cause endometrial polyps, simple and complex endometrial hyperplasia, and in some instances, atypical hyperpla-

sia and endometrial carcinoma. Consequently, a subset of peri-menopausal women may develop AUB, which significantly impacts their physical and psychological well-being and overall quality of life. Therefore, identifying the underlying cause promptly is imperative. The primary objective of evaluating AUB accurately is to diagnose the bleeding's aetiology, facilitate the early detection of serious conditions such as endometrial atypical hyperplasia and cancer, and enable the implementation of suitable treatment strategies [17].

The diagnosis of peri-menopausal AUB relies on the patient's history, gynaecological examination, and appropriate laboratory and imaging investigations, with the final pathological diagnosis serving as the gold standard. Transvaginal ultrasound has emerged as the preferred initial imaging modality for patients with AUB, owing to its excellent feasibility, cost-effectiveness, safety, non-invasiveness, and repeatability. It is particularly advantageous in the primary screening for the aetiology of AUB, capable of diagnosing structural causes of abnormal bleeding such as polyps, adenomyosis, leiomyomas, hyperplasia, and malignancy, as well as aiding in the diagnosis of ovulatory dysfunction [8]. Despite its strengths, the specificity and sensitivity of transvaginal ultrasound are limited, and it alone cannot definitively exclude organic causes of AUB [18]. Hysteroscopy, a minimally invasive technique, allows direct observation of the endometrium's thickness and colour, the opening of the bilateral fallopian tubes, uterine angles, cavity shape, and cervical canal. It excels in detecting small lesions that transvaginal ultrasound may miss, and electroresection or curettage of lesions can enhance the sen-

Table 3. Diagnostic efficacy of different methods for peri-menopausal AUB (n = 176).

Grouping	Pathological diagnosis		Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
	Pathological	Physiological				
Transvaginal ultrasound						
Abnormal	139 (95.2)	7 (4.8)	89.7	66.7	95.2	46.7
Normal	16 (53.3)	14 (46.7)				
Hysteroscope						
Abnormal	147 (96.7)	5 (3.3)	94.8	76.2	96.7	66.7
Normal	8 (33.3)	16 (66.7)				
Two kinds of combination*						
Abnormal	151 (97.4)	4 (2.6)	97.4	81.0	97.4	81.0
Normal	4 (19.0)	17 (81.0)				

Note: * indicates transvaginal ultrasound combined with hysteroscopy. AUB, abnormal uterine bleeding.

Table 4. Comparison of etiology between pathology and different methods in the diagnosis of peri-menopausal AUB (n = 176).

Pathological diagnosis	Number of cases	Transvaginal ultrasound		Hysteroscope		χ^2	<i>p</i>	OR (95% CI)
		In accordance with	Not in accordance with	In accordance with	Not in accordance with			
Uterine leiomyoma	19	17 (89.5)	2 (10.5)	19 (100)	0 (0.0)	2.111	0.146	0.895 (0.767–1.044)
Endometrial polyps	75	58 (77.3)	17 (22.7)	70 (93.3)	5 (6.7)	7.670	0.006	0.244 (0.085–0.701)
Adenomyosis	4	3 (75.0)	1 (25.0)	4 (100)	4 (0.0)	1.143	0.285	0.750 (0.426–1.321)
Endometrial malignant transformation	7	4 (57.1)	3 (42.9)	6 (85.7)	1 (14.3)	1.400	0.237	0.222 (0.017–2.970)
Atypical hyperplasia of endometrium	6	4 (66.7)	2 (33.3)	5 (83.3)	1 (16.7)	0.444	0.505	0.400 (0.0267–6.176)
Benign hyperplasia	42	30 (71.4)	12 (28.6)	35 (83.3)	7 (16.7)	1.700	0.192	0.500 (0.175–1.432)
Normal endometrium	21	14 (66.7)	7 (33.3)	16 (76.2)	5 (23.8)	0.467	0.495	0.625 (0.161–2.419)
Else	2	1 (50.0)	1 (50.0)	2 (100)	0 (0.0)	1.333	0.248	0.500 (0.125–1.999)

sitivity and accuracy of the aetiological diagnosis of AUB. Despite its growing popularity, hysteroscopy faces limitations in clinical practice, such as cost, technical complexity, invasiveness, and patient tolerance.

Wang *et al.* [19] demonstrated that combining transvaginal ultrasound, enhanced by the K-means clustering colour image segmentation algorithm, with hysteroscopy significantly increased diagnostic sensitivity. This study's results, encompassing 176 peri-menopausal AUB patients, revealed 21 cases of normal endometrium, 42 of benign endometrial hyperplasia, 75 of endometrial polyp, 7 of endometrial carcinoma, 4 of adenomyosis, 6 of atypical endometrial hyperplasia, 19 of uterine leiomyoma, and 2 of other uterine lesions. In diagnosing AUB caused by endometrial polyps, the concordance rates for hysteroscopy and transvaginal ultrasound were 93.3% and 77.3%, respectively, with the difference being statistically significant ($\chi^2 = 7.670$, $p = 0.006$), indicating hysteroscopy's

superior efficacy in detecting endometrial polyps. The concordance rates for diagnosing AUB caused by normal endometrium, uterine leiomyoma, malignant transformation of the endometrium, adenomyosis, atypical hyperplasia, benign hyperplasia, and other factors did not show a statistically significant difference between the two methods. This discrepancy from previous findings may be attributable to factors such as small sample size. In diagnosing peri-menopausal AUB, transvaginal ultrasound showed a sensitivity of 89.7%, a specificity of 66.7%, and a negative predictive value of 46.7%. Hysteroscopy demonstrated higher sensitivity, specificity, and negative predictive value of 94.8%, 76.2%, and 66.7%, respectively. The combined diagnostic approach yielded sensitivity and specificity rates of 97.4% and 81.0%, respectively, and a negative predictive value of 81.0%, surpassing the individual use of transvaginal ultrasound and hysteroscopy. These findings aligned with the research by Wang *et al.* [19]. The

consistency between transvaginal ultrasound results and the pathological diagnosis was moderate ($Kappa = 0.475$), while hysteroscopy showed substantial consistency ($Kappa = 0.669$). The combined use of transvaginal ultrasound and hysteroscopy presented a higher consistency with the pathological diagnosis ($Kappa = 0.784$), suggesting that this combined approach offers superior diagnostic efficacy in the evaluation of peri-menopausal AUB.

Strengths and Limitations of the Study

This study was conducted at a tertiary hospital and involved transvaginal ultrasound performed by a technician with over five years of experience, alongside hysteroscopy carried out by a seasoned gynaecologist with more than a decade of expertise. Consequently, the findings are both accurate and reliable. Additionally, the research offers invaluable insights by juxtaposing the outcomes of both examinations against pathological diagnoses. Nonetheless, the study is marred by the generally low quality of the included studies and the application of inclusion and exclusion criteria that overlook potential confounding factors, such as menstrual status. These oversights may introduce bias into the study's conclusions. Thus, given the limitations in the quality and scope of this research, further investigations are warranted to corroborate and refine these findings.

5. Conclusions

In conclusion, according to the study of 176 women with AUB during perimenopause, we know that transvaginal ultrasound and hysteroscopy possess significant diagnostic utility in identifying the aetiology of perimenopausal AUB. Transvaginal ultrasound, being both safe and relatively cost-effective, offers considerable benefits in the initial screening for the causes of AUB. However, the potential for missed or incorrect diagnoses remains. Although hysteroscopy is more expensive and less convenient, its integration with pathological examination significantly enhances the detection rates of cancerous and precancerous lesions. The combined application of transvaginal ultrasound and hysteroscopy improves the diagnostic accuracy for endometrial lesions. Therefore, it is recommended that this combined approach be employed in the evaluation of peri-menopausal AUB patients to promptly identify the cause of AUB and initiate appropriate treatment.

Availability of Data and Materials

The data that support the findings of this study are available from Second Affiliated Hospital of Xinjiang Medical University but restrictions apply to the availability of these data, which were used under license for the current study and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Second Affiliated Hospital of Xinjiang Medical University.

Author Contributions

BT: conceptualization, data curation, formal analysis, investigation, methodology, writing - original draft, writing - review & editing. QHZ: conception, funding acquisition, resources. Both authors contributed to editorial changes in the manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work. Both authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

Informed consent was obtained from all individual participants included in the study. The Ethics Committee of the Second Affiliated Hospital of Xinjiang Medical University granted approval for this study (Ethics Approval Number: KY2024032030).

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Conflict of Interest

The authors declare no conflict of interest.

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