Review Article

Diagnostic Comparison of Transabdominal and Transvaginal Ultrasound in Determining Endometrial Thickness

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Abstract: The investigation of the endometrium is essential for any pathology related to the female menstrual cycle. Endometrial thickness serves as a significant biomarker in transvaginal and pelvic ultrasound examinations, closely tied to gynecological function. To enhance the precision of predicting endometrial thickness, we have synthesized various studies and literature to incorporate bleeding patterns and combine transabdominal and transvaginal ultrasounds. These techniques offer accurate and noninvasive means of exploring endometrial thickness (ET). However, the current body of literature lacks a unanimous agreement on the threshold value for defining normal ET levels, especially when considering women who are symptomatic or asymptomatic during both pre and post menopause stages. This study aims to compare ultrasound findings in endometrial thickness between transabdominal and transvaginal approaches. Several studies suggest that pelvic ultrasound provides a reliable method for diagnosing endometrial conditions and assessing uterine pathologies by observing internal genitalia morphology. Conversely, transvaginal ultrasound is suggested as a primary approach due to its superior resolution and broader field of view, positioning it potentially as the first-line technique.

Keywords: Transvaginal ultrasound, Biopsy, Endometriosis, Malignancy, Polyp, Endometrial thickness.

INTRODUCTION

The endometrium, a specialized and intricate organ within the human body, plays a vital role in maintaining the openness of the uterine cavity. During the reproductive years, the human endometrium experiences repetitive sequences of growth and decline. These patterns encompass distinct degradation of tissues, guided by dynamic changes in ovarian steroid hormones like estrogen and progesterone. The intricate and layered structure of the endometrium consists of two primary sections: the functionalist layer, which is positioned next to the uterine cavity, and the basalis layer, situated adjacent to the myometrium. Within these layers, a diverse array of cell types exist, including luminal and glandular epithelial cells, endometrial stromal cells, immune cells, and vascular cells [1]. Menstruation is the cyclic process of shedding the outermost functional layer of the endometrium when embryonic implantation does not occur [2]. Ultrasound provides crucial insights and a comprehensive overview of the anatomical aspects of reproductive organs, coupled with physiological assessment. Yet, a significant gap remains in comprehending and interpreting sonographic observations of the endometrium. Due to its cost-effectiveness, safety, and user-friendly nature, ultrasound stands as a highly preferred diagnostic approach. Despite numerous investigations into endometrial thickness, growth, and sonographic patterns in relation to pregnancy rates during in vitro fertilization (IVF) cycles, the findings have shown inconsistency. In general, the available data advise caution against basing clinical decisions solely on endometrial thickness. The presence of a three-layer ultrasound pattern indicates normal follicular/proliferative dynamics [3, 4]. Endometrial thickness is acknowledged as a predictive factor for achieving positive outcomes in assisted reproduction. In cases where the endometrium is deemed to have 'reduced' thickness, healthcare professionals and individuals must determine the appropriate course of action for the treatment cycle. This guideline aims to provide an evidence-based strategy for the evaluation and management of individuals with a thin endometrial lining in assisted reproduction procedures, including controlled ovarian stimulation and in vitro fertilization (IVF) [5]. The endometrium, a layer of epithelial tissue in the mammalian uterus, exhibits distinct physiological characteristics during various stages of the menstrual cycle, including the proliferative, secretory, and menstrual phases.

SONOGRAPHIC PATTERN

A typical endometrium displays consistent thickness, a uniform texture, and no abnormality in the submucosal or myometrial regions. An endometrial thickness (ET) below 5 mm typically carries a significant adverse predictive significance for endometrial disorders. When an increased ET crosses 8 mm during the proliferative phase or 16 mm during the secretory phase, it is categorized as abnormal. For women who are not yet menopausal, the usual endometrium's thickness fluctuates constantly throughout the menstrual cycle. Endometrial thickness is a crucial metric for assessing the risk of endometrial cancer in women who have gone through the menopause. Although different research shows different threshold values for endometrial thickness, it is widely accepted that a thickness of 3–5 mm or more raises the risk of endometrial cancer. But endometrial

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thickness solely cannot be used to diagnose endometrial problems because readings in this range require additional testing [6]. As age advances and the endometrial thickness rises, the potential for malignancy also escalates [7]. Transvaginal and pelvic ultrasound can readily identify deviations from the typical endometrial structure, including inadequate thickness and injuries affecting the decidua basalis [8].

ULTRASOUND MODALITIES

Ultrasound utilizing specialized obstetric imaging systems has become the most prevalent diagnostic method for detecting reproductive organs [9]. Conventionally, routine pelvic ultrasounds are employed to evaluate numerous endometrial pathologies [10]. Fig. (**1**) shows Transabdominal Ultrasound Findings for the Uterus of a 17-Year-Old Female: A pear-shaped uterus following puberty, with the uterine fundus growing more than the cervix [11].

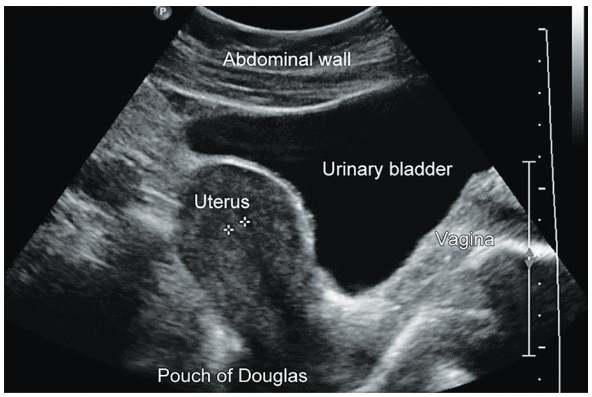

Fig. (1). Typical Transabdominal Ultrasound Findings of a 17-Year-Old Female's Uterus: A Pear-Shaped Uterus after Puberty, with the Uterine Fundus Exhibiting Greater Growth in Comparison to the Cervix [12].

The pelvic ultrasound is conducted through the transabdominal method, employing a standard 3.5-5 MHz convex transducer with a full bladder. This procedure allows for visualization of the uterus and ovaries in both transverse and longitudinal views. The assessment of the endometrium includes measuring its anteroposterior diameter [13]. The precision of transvaginal ultrasound has been documented across various studies, and certain findings exhibit similarity to those obtained from transabdominal scans. Additionally, it has been deduced that the utilization of TVS diminishes the requirement for curettage and endometrial biopsy [14]. The preferred diagnostic method for prioritizing patients with irregular endometrial thickness is transvaginal ultrasound [15]. Pelvic ultrasonography is frequently requested for postmenopausal individuals experiencing gynecologic concerns or unusual physical exam results. As part of the imaging procedure, measuring endometrial thickness is typically conducted, and in cases where postmenopausal bleeding is absent, physicians are then faced with addressing an increased endometrial thickness. However, a standardized approach to managing incidentally identified thickened endometrial linings in postmenopausal women has not been established. Transvaginal ultrasound stands as a dependable technique, demonstrating extensive applicability and clinical effectiveness, and enjoying widespread acceptance from both healthcare providers and patients alike. The evaluation of endometrial thickness using ultrasound measurements holds considerable significance in the diagnosis of both benign and neoplastic endometrial conditions across all age groups of women. In the case of women who experience postmenopausal bleeding, numerous studies have confirmed Transvaginal Sonography-Evaluated Endometrial Thickness (TVS-ET) as an initial screening method. This aims to establish a potential cutoff point for endometrial thickness that can rule out the presence of endometrial issues. Several studies have suggested different cutoff values for endometrial stripe, ranging from 3 to 14 mm, to detect endometrial problems in premenopausal women as well [16]. The evaluation of endometrial thickness is displayed in Fig. (**2**). From the fundal region of the uterus, which is typically the thickest section, measurements are made from the basal layer of the anterior uterine wall to the basal layer of the posterior uterine wall [17].

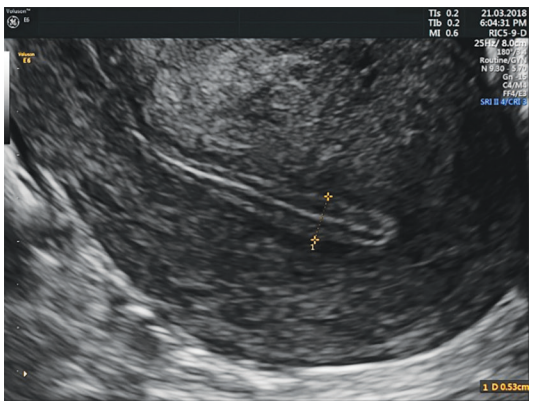

Fig. (2). Evaluation of Endometrial Thickness [18].

Currently, transvaginal ultrasound has emerged as a standard procedure for assessing the endometrium, surpassing pelvic ultrasound due to its ease and non-invasive nature. Several sonographic parameters, including endometrial thickness, volume, pattern, and blood flow, are typically used to determine endometrial receptivity. Among these, endometrial thickness is widely acknowledged as an indicator for predicting receptivity. Nonetheless, the ability of endometrial thickness to forecast pregnancy outcomes remains a topic of debate [19]. Women exhibiting an endometrial thickness greater than 8 mm and a triple-line pattern experienced notably elevated rates of clinical pregnancy. However, the capacity to foresee live birth outcomes was not feasible based solely on either endometrial thickness or endometrial pattern, even when considering their combination [20].

MEASUREMENT OF ENDOMETRIUM

Endometrial thickness (ET) is defined as the maximum dimension of the endometrium along the sagittal plane, covering both sides. An unbroken line extending from the cervical canal to the intrauterine cavity should be visible. Employing the "+" cali-

per, measurements are captured on both sides of the myometrium-endometrial junction, with the image enlarged for improved visibility. The most substantial point of the endometrium, perpendicular to its center line, is then quantified (Fig. **3A**). The sum of the thicknesses of both layers is recorded in millimeters (mm), rounded to one decimal place. In situations involving fluid-filled cavities, ET is determined by measuring on both sides and adding the values together. (Fig. **3B**). If the endometrium exhibits asymmetrical thickness, separate measurements are recorded for the maximum anterior and posterior thicknesses. If the total endometrium isn't clearly visible, the result is categorized as "unmeasurable/undefined" and not recorded.

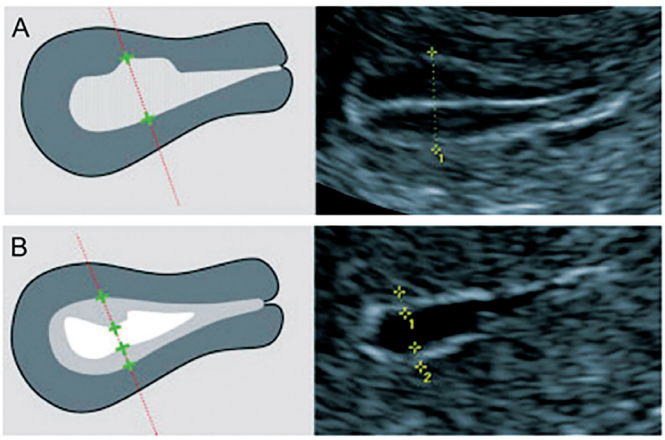

Fig. (3). Evaluation of endometrial thickness using grayscale ultrasonography. Thick endometrium with a triple layer echogenic pattern is visible [21].

The central line of the endometrium could exhibit a straight, curved, irregular, or undefined pattern. The junction between the endometrium and the myometrium was observed to be regular, irregular, discontinuous, or indistinct [22].

While a range of histological conditions related to the endometrium and intracavity often display anticipated sonographic traits, our data underscore instances within each histological category where unconventional features are detected. For instance, a polyp might not exhibit a prominent vessel (pedicle sign), an atrophic endometrium could give the appearance of being relatively thick, or endometrial cancer might manifest in a thin endometrial lining. Physical limitations can sometimes cause deviations from normal morphology. For example, Doppler signals may not appear when the uterus is positioned upright or when there is a significant distance between the ultrasound probe and the endometrium. These non-standard findings could also be caused by histological characteristics, such as the presence of endometrial cysts in cases of cystic atrophy or exceptional outliers, such as those seen in cases of endometrial cancer linked to an endometrial thickness of 5 mm or less [23]. Ultrasound assessment of endometrial thickness plays an important part in the diagnosis of endometrial pathologies. The significance of endometrial thickness is pivotal in identifying individuals with an elevated risk of malignancy, particularly when combined with coexisting medical conditions [24].

INCIDENCE OF ABNORMALITIES

Dysregulation in the remodeling and functioning of the endometrium can give rise to a range of disorders that impact a significant portion of the female population. These conditions encompass a range of issues including infertility, complications during pregnancy, endometriosis, and endometrial cancers. For example, endometriosis, characterized by the growth of endometrial tissues outside the uterus, resulting in pelvic pain, excessive bleeding, and infertility, affects approximately 10 to 15% of women in their reproductive years. Fig (**4a**) depicts Grade-1 endometrioid carcinoma and was obtained at a 0.6 kHz pulse repetition frequency (PRF). Fig.(**4b**) displaying the characteristic bright edge sign and a dominating vessel in Grade-1 endometrioid carcinoma. The PRF used to capture these pictures was 0.9 kHz. Grayscale pictures combined with matching bidirectional power Doppler pictures taken at 0.3 kHz PRF. Fig. (**4c**) Images of a patient with ascites, extensive peritoneal carcinomatosis, omental and infiltrative mesenteric deposits, and bilateral pleural effusion are consistent with a patient diagnosed with serous endometrial cancer at Stage IVB [25]. Endometrial cancer, the most common malignancy of the female reproductive system, impacts around 3% of women, with the highest prevalence observed in North America and Europe. In recent years, there has been a consistent global increase in cases of abnormal endometrial thickness, with nearly 2 million new cases emerging annually. With improving economic conditions, the incidence of this condition in China is also steadily rising, making it the second most prevalent cancer after cervical cancer. Additionally, deviations from the normal endometrial pattern are observed in around 70% to 80% of postmenopausal individuals, about 15% of those between the ages of 40 and menopause, and roughly 10% to 15% of patients under 30 years old. Furthermore, endometrial cancer (EC) is the predominant indication of postmenopausal bleeding [26].

Vaginal bleeding occurring after menopause, known as postmenopausal bleeding, is present in around Ninety percent of women diagnosed with endometrial cancer exhibit this symptom, which holds substantial sensitivity as a trigger for diagnostic evaluation.

Fig. (**5**) shows patient with irregular uterine bleeding in the premenopausal phase showed a slender endometrium, adenomyosis, and endometrial cancer, with adenomyosis exhibiting a characteristic myometrial vessel pattern [27]. Three possible approaches are currently suggested by the American College of Obstetrics and Gynecology for patients who present with postmenopausal bleeding: transvaginal ultrasonography, uterine dilatation and curettage, and endometrial biopsy. TVUS is unique among these options because it is the only noninvasive technique in the current diagnostic methodology. Transvaginal ultrasound is used to determine endometrial thickness, which needs to be more than a certain threshold (4 mm) in order to justify more invasive operations like dilation and curettage or biopsy. Strong cases have been made for the use of TVUS to decrease needless invasive interventions in women with PMB in established guide-

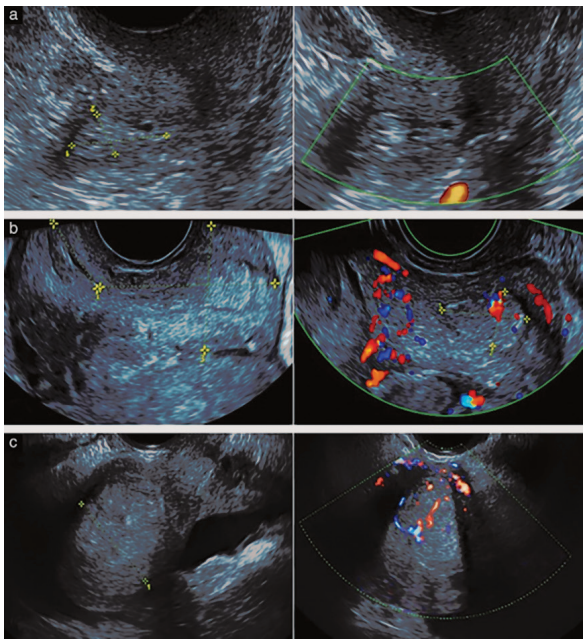

Fig. (4). (**a**) Grayscale images, along with their corresponding power Doppler images, portray Grade-1 endometrioid cancer, Stage IA, captured with a pulse repetition frequency (PRF) of 0.6 kHz. (**b**) Illustrated here are grayscale images matched with respective color Doppler images, revealing a dominant vessel and the distinctive bright edge sign within Grade-1 endometrioid cancer, Stage IA. This sign potentially indicates the presence of cancer within a polyp. These images were acquired at a PRF of 0.9 kHz. (**c**) Grayscale images paired with corresponding bidirectional power Doppler images captured at a PRF of 0.3 kHz. These images correspond to a patient diagnosed with serous endometrial cancer, Stage IVB, who exhibits ascites, widespread peritoneal carcinomatosis, omental and infiltrative mesenteric deposits, and bilateral pleural effusion [28].

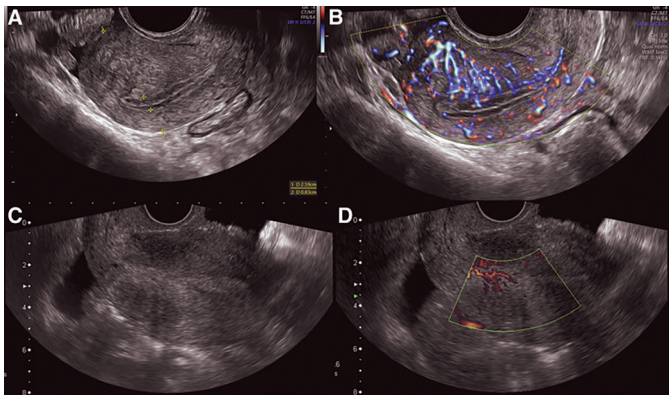

Fig. (5). In women within the premenopausal phase who are encountering irregular uterine bleeding, a slender endometrium was observed (depicted in images **A** and **C**). Upon incorporating Doppler findings, patient A exhibited a characteristic myometrial vessel pattern, indicative of adenomyosis (illustrated in image **B**), while patient C displayed anomalous subendometrial vascularity (depicted in image **D**), in alignment with a diagnosis of endometrial cancer [29].

lines and earlier research. For this method, the claimed negative predictive scores vary from 99% to 100% [30].

In order to safeguard the well-being of the female reproductive system, the assessment of endometrial sampling should be incorporated into the evaluation process for all women experiencing postmenopausal bleeding, irrespective of their endometrial thickness [31]. Several studies have confirmed the heightened sensitivity, specificity, and precision of transvaginal ultrasound in comparison to pelvic ultrasound in diagnosing the reasons behind endometrial thickening, the integration of other clinical aspects like bleeding patterns has not been explored. Thus, in this investigation, we assessed the precision of both pelvic and transvaginal ultrasounds. Additionally, a combined analysis of these ultrasound approaches was employed to examine the factors associated with normal and abnormal endometrial thickness. The aim is to potentially offer valuable insights for clinical diagnosis and treatment strategies [32].

ENDOMETRIAL CONTRACTILITY

An intriguing element within endometrial physiology involves sub endometrial contractility, demonstrated by occurrences referred to as "endometrial waves." These waves are observable during transvaginal ultrasound assessments of the uterus. Unlike invasive uterine pressure catheters, ultrasound serves as a noninvasive tool for assessing contractility. These waves emerge from the myometrial layer beneath the endometrium and are influenced by hormonal fluctuations. Comprehensive research has delved into endometrial "waves," revealing diverse patterns, directions, and rhythmic behaviors, all closely tied to the menstrual cycle. During the early follicular phase, wave movement extends from the fundus to the cervix, while the late follicular and peri-ovulatory phases are characterized by waves moving from the cervix to the fundus. Given the necessity of uterine contractility for sperm movement and embryo transport, followed by uterine quiescence to facilitate embryo implantation, the study and interpretation of these endometrial waves hold significant biological significant [33]. This research furnishes instructive, evidence-driven information regarding the sonographic observations pertaining to both typical and atypical endometrial thickness. These findings are poised to assist healthcare professionals in discerning both malignant and non-malignant endometrial conditions during the diagnostic process [34]. Achieving an ideal endometrial thickness is crucial for maintaining a regular reproductive cycle in women. Ultrasound has been firmly established as a valuable, straightforward, and non-intrusive approach to evaluate endometrial thickness [35].

TAS Vs TVS

When compared to pelvic ultrasound, transvaginal ultrasound technology has significantly improved doctors' ability to examine the endometrium throughout the last 20 years. It has been shown to be an accurate, non-invasive method for disease staging and early diagnosis. Specific ultrasound characteristics have been established by an international agreement, represented by

the International Endometrial Tumor Analysis group, with an emphasis on accuracy of diagnosis with regard to endometrial thickness. However, there is notable variation in the diagnostic precision of TVUS within categories, such as those who are pre- or postmenopausal. The determination of endometrial thickness in pre- and postmenopausal women is complicated by the cyclical changes that occur in the endometrium during the reproductive years of women. It is still unclear if TVUS is definitively helpful in ruling out malignant endometrial abnormalities in premenopausal women. There is a lack of information on how well endometrial thickness can be measured in premenopausal women who experience irregular uterine bleeding. This group of patients is susceptible to periodic changes in the endometrium due to the hormone cycle. TVUS should ideally be carried out between days four and six of the menstrual cycle, when the ET is at its thinnest [36]. In many researches, endometrial thickness has been assessed most commonly during the proliferative phase. However, the physiological changes in the development of the endometrium varies between the follicular and luteal phases, resulting in contrasting appearances when observed using both pelvic and transvaginal ultrasound techniques (as observed in various studies). Incorporating the sonographic measurement of endometrial thickness along with individual risk factors can significantly contribute to the effective management of postmenopausal patients who are encountering abnormal bleeding [37]. This involves deciding whether histological evaluation is necessary in cases of higher risk or opting for a more conservative approach. Our findings underscore that an endometrial thickness of ≤ 4.0 mm reliably indicates endometrial atrophy, suggesting a cautious observation strategy when the patient recognizes the significance of thorough follow-up. This approach has the potential to reduce the need for invasive procedures while minimizing any undue delay in the diagnosis of cancer [38]. Enhancements in transvaginal ultrasound technology have notably elevated clinicians' capability to distinguish varying levels of endometrial thickness. The primary benefit of ultrasound imaging lies in its potential for superior accuracy, especially when conducted by skilled practitioners, making it a valuable tool for preoperative categorization of endometrial pathologies [39].

The primary focus of this study was to rule out the features of the endometrium in both trans abdominal and transvaginally. This study also discussed the sonographic features of the endometrium abnormalities like endometriosis, endometrium cancer and abnormal uterine bleeding [40].

RESULT

Transvaginal ultrasound (TVS) excels over transabdominal ultrasound in accurately assessing endometrial thickness, demonstrating heightened sensitivity and precision in diagnosing pelvic pathologies. Furthermore, the determination of pelvic mass type was notably refined when a transvaginal study followed TAS in cases of abnormal uterine bleeding. Transvaginal ultrasound presents the opportunity to tailor endometrial biopsy procedures for individuals or to confidently avoid additional examinations in women with a low risk of endometrial cancer. By employing transvaginal ultrasonography, endometrial thickness below 5mm signifies a lower risk of malignancy, whereas a higher endometrial thickness corresponds to increased risk. As such, TVS ultrasound enables the differentiation between patients at low risk and those at high risk. Transvaginal ultrasound displays significant sensitivity in detecting endometrial cancer when utilizing a 3-mm threshold. It has the capacity to identify individuals with postmenopausal bleeding (PMB) who possess a significantly low probability of having endometrial cancer, thus potentially circumventing the need for more invasive endometrial biopsy procedures [41].Transvaginal ultrasound (TVS) effectively determines endometrial thickness and accurately detects various reproductive pathologies. On the contrary, pelvic ultrasound scans necessitate a full bladder before the procedure, while TVS scans may induce slight discomfort in some women. Notably, TVS scans require no prior patient preparation.

CONCLUSION

Transvaginal ultrasound (TVS) is a highly sensitive diagnostic tool for endometrial cancer, detecting pelvic pathologies with a 3-mm threshold, potentially reducing the need for more invasive endometrial biopsy procedures in individuals with low endometrial cancer risk. Transvaginal ultrasonography indicates that endometrial thickness below 5mm reduces the risk of malignancy, while higher thickness indicates an increased risk.

CONFLICT OF INTEREST

Declared none.

ACKNOWDEGMENTS

Declared none.

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