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Assessing the Diagnostic Performance of MRI in Perimenopausal Bleeding in Comparison with Transvaginal Sonography

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ABSTRACT
Abnormal uterine bleeding (AUB) is a common and concerning symptom in perimenopausal women, often requiring accurate differentiation between benign and malignant uterine lesions. This study aimed to compare the diagnostic performance of Transvaginal Sonography (TVS) and Magnetic Resonance Imaging (MRI) in the evaluation of uterine lesions in women with perimenopausal bleeding, with histopathological examination as the gold standard. This prospective observational study was conducted at Sree Mookambika Institute of Medical Sciences from June 2024 to December 2024. 50 patients with perimenopausal bleeding who underwent TVS, MRI, and subsequent histopathological confirmation were included. The diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of TVS and MRI were calculated and compared. MRI demonstrated superior diagnostic performance compared to TVS. The overall accuracy of MRI in characterizing uterine lesions was 97.09%, while that of TVS was 83.47%. For detecting malignant lesions, MRI showed a sensitivity of 99.98% and specificity of 95.76%, whereas TVS had a sensitivity of 62% and specificity of 95.25%. Diffusion-weighted imaging (DWI) on MRI achieved 100% sensitivity and specificity in differentiating benign from malignant lesions. MRI was particularly superior in detecting myometrial invasion, parametrial involvement, cervical extension, adnexal lesions, and lymph node metastases. MRI is a highly accurate and reliable imaging modality for the evaluation of uterine lesions in perimenopausal bleeding, outperforming TVS, especially in characterizing malignant lesions and assessing local extension. While TVS remains a useful initial screening tool due to its accessibility and low cost, MRI should be considered as a valuable problem-solving tool or primary imaging modality in sonographically indeterminate or suspicious cases to improve diagnostic precision and clinical decision-making.

INTRODUCTION

Abnormal uterine bleeding (AUB) is a common gynecological condition, impacting approximately 30% of women of reproductive age and up to 50% of perimenopausal women. It is characterized as "excessive hemorrhaging that happens outside of the normal menstrual cycle"[7]. The causes of aberrant uterine bleeding in perimenopausal women primarily involve physiological hormonal changes or neoplastic tumors, which may be benign or malignant. Moreover, one in every 40 women has a lifelong risk of developing uterine cancer, with over 85% of cases originating from undeveloped nations[3].

The management of uterine lesions is complex and depends significantly on diagnostic methods for early identification and precise prognostication. Among the several imaging modalities, ultrasonography (TAS and TVS) remains predominant because to its extensive availability, patient compliance, and affordability. However, it possesses drawbacks including a limited field of view, constraints in obese patients, and reliance on the operator's proficiency.

Due to its superior soft-tissue contrast and multiplanar capabilities, MRI can more precisely delineate the extent of lesions. Nonetheless, it is utilized infrequently due to its elevated expense, limited availability, and extended procurement duration.

Efforts are currently being made to improve the outcomes of uterine disease patients by detecting early-stage conditions through the combined use of imaging modalities. Further research is required to explore the advantages of novel imaging modalities to enhance the existing circumstances. The study aims to furnish imaging characteristics for the early detection, characterisation, and assessment of uterine diseases, along with pertinent information to assist doctors in making informed decisions among various imaging modalities. Comprehending the numerous imaging modalities and their optimal application for diagnosing the diverse range of uterine lesions is crucial for enhancing disease outcomes and long-term prognosis. We want to offer a research study comparing the efficacy of transvaginal sonography (TVS) and magnetic resonance imaging (MRI) in characterizing uterine lesions.

Aim:

- To evaluate the efficacy of Transvaginal Ultrasound (TVS) and Magnetic Resonance Imaging (MRI) in the diagnosis as well as assessment of lesions associated with perimenopausal hemorrhage.
- To evaluate the precision of Transvaginal ultrasonography vs Magnetic Resonance Imaging.
- To evaluate the diagnostic efficacy of Transvaginal ultrasound and Magnetic Resonance Imaging regarding sensitivity and specificity by matching imaging findings with histopathological results.

MATERIALS AND METHODS

This prospective observational study was carried out in our hospital after receiving approval from the Sree mookambika institute of medical sciences ethics and scientific review committees. The trial took place from April 2024 to September 2024.

Patients who were referred to Sree mookambika institute of medical sciences department of radiodiagnosis for a radiographic assessment of abnormal uterine hemorrhage met the inclusion criteria. Women with bleeding issues, endocrine abnormalities, pregnancy, and single status were excluded. Furthermore, patients with a pacemaker or a severely positioned foreign body were excluded from MRI screening. Ultimately, patients for whom histology reports were unattainable due to the absence of surgical intervention were omitted from our analysis.

All patients received the following procedures: Patients were chosen according to the inclusion and exclusion criteria. The technique was elucidated to the patients and their attendants, and informed written agreement was obtained from all parties involved. A comprehensive patient history, physical examination results, and radiographic assessments were documented and organized in tabular form. Evaluations were performed using MRI (1.5T), transvaginal ultrasound (siemens acuson x300 machine), and transabdominal ultrasound.

The size of the uterus, along with its myometrial and endometrial features, including any mass lesions, were measured in both sagittal and transverse views. Color Doppler was then used to further analyze the lesion. We also evaluated the occurrence of concomitant pathology in the adnexa and other pelvic organs. An MRI was performed on each patient to further assess the uterine lesions. An MRI was conducted using a 1.5T. The following sequences were executed in the MR evaluation of all patients: Axial T1, axial, sagittal, and coronal T2, axial fat-saturation T1, axial oblique T2 aligned with the short axis of the uterine corpus, axial oblique T2 aligned with the short axis of the cervix, and diffusion-weighted imaging (DWI). Depending on the patients' tentative diagnosis, additional sequences, including contrast, were developed.

The MRI lesion was described using the following points: The lesion's location, The dimensions and

morphology of the lesion, Homogeneous/ heterogeneous, well/ill-defined. Examining the lesion margin and contour, looking for contrast enhancement, calcification, hemorrhage, cystic or necrotic areas, mass effect, involvement of nearby structures, and appearance on matching ADC maps and diffusion weighted images. The findings are contrasted and correlated with histological examination.

Sample Size and Statistical Analysis: A cumulative sum of 62 patients showing perimenopausal hemorrhage received transvaginal sonography in the Department of Radiodiagnosis at, Sree mookambika institute of medical sciences from June 2024 to December 2024, following the obtaining of written consent. Of them, 50 individuals underwent MRI and histological analysis. patients were lost to follow-up, while four underwent surgery without prior MRI. Data were organized in a Microsoft Excel spreadsheet for analysis. Additional data visualization was done using a variety of tables and charts. The data was analyzed using SPSS. The mean, median, and standard deviation of the quantitative variables were computed. The cutoff value was determined using the Youden index. A P value of less than 0.05 was accepted as statistically significant.

RESULTS AND DISCUSSIONS

Patients with benign lesions had a substantially lower mean age (43.61±5.5 vs. 50.60 ±4.05, P = 0.032) than those with malignant lesions. 28 to 65 years old was the age range.

Every patient had AUB when they first arrived. 24 out of 50 people (48%) experienced pelvic pain, while 26 out of 50 people (52%) experienced vaginal discharge.

62% of individuals on TVS had uterine enlargement. Heterogeneous myometrium was seen in 12 out of 50 cases (24%), myometrial mass in 17 out of 50 cases, myometrial cysts in 11.5% of cases, and echogenic nodules in 5.8% of cases. In identifying adenomyosis, we found that myometrial cysts had 100% specificity and changed myometrial echotexture had 100% sensitivity.

18 out of 50 patients (36.6%) had an ill-defined junctional zone on TVS, although a larger percentage of patients [28 out of 50 (48.2%)] had the thickening of the junctional zone on MRI, which is its comparable counterpart. The thickening of the junctional zone was identified as the most sensitive (100%) MRI criterion for the diagnosis of adenomyosis.

In 38.5% of instances, myometrial invasion was detected by MRI, whereas only 19.2% of cases could be diagnosed by TVS. Minor myometrial intrusions, previously undetected by transvaginal sonography, can also be identified on MRI. Additionally, we established a cut-off point for endometrial thickness of 10.5 mm, below which no cancer was discovered.

Three (5.7%) of the 50 cases had bladder and bowel involvement, six (11.5%) had a cervical mass lesion on TVS, one had parametrial invasion, and some had an adnexal lesion. Nine (21.5%) of the 50 cases had cervical involvement on MRI (three had an altered cervical signal, and six had expansile cervical mass). On MRI, a greater proportion of patients also demonstrated adnexal involvement and parametrial invasion. Consequently, MRI demonstrated superior efficacy compared to TVS in identifying local extension to the cervix and pelvic organs.

MRI identified lymph node metastases in seven instances, although TVS did not detect any. Most lesions (13 of 17) exhibiting peripheral vascularity on color Doppler were confirmed as fibroids, demonstrating a sensitivity of 66%. 25 of 50 cases exhibited heterogeneous contrast enhancement on MRI, which was identified as a robust predictor of malignancy or inflammatory etiology.

All lesions exhibiting limited diffusion, comprising 41.7%, were determined to be malignant, whereas all lesions demonstrating facilitated diffusion, accounting for 64.3%, were classified as benign upon histopathological examination. This indicates that diffusion-weighted imaging (DWI) possesses 100% specificity and sensitivity in distinguishing between benign and malignant lesions.

In contrast to 44.4% of cases on MRI, only 28.4% of cases on TVS had the morphological characteristics that typically predict malignancy, such as an ill-defined endometrial margin, mass lesion, heterogeneity of lesion, myometrial invasion, and internal vascularity on color Doppler, as well as ancillary characteristics that include parametrial involvement, invasion of neighboring structure, and heterogenous contrast enhancement with necrosis and hemorrhage. In the comparison of these modalities with histology, MRI shown a high accuracy of 97.09%, whereas TVS exhibited an accuracy of 83.47% in the characterization of uterine lesions.

In our study, patients between the ages of 43 and 50 made up the majority (45.2%). The demographic results of our study are consistent with those of earlier research by Pujitha *et al*.[1] and Meena Jain *et al*.[4].

The most frequent benign diseases found on TVS in our study were endometrial polyps (15.56%), endometrial hyperplasia (21.2%), uterine fibroid and adenomyosis (21.3% each), and endometritis (10.3%). Endometrial carcinoma was found in 16.6% of instances of malignant uterine lesions, followed by cervical cancer in 11.3% of cases. Meena Jain *et al*.[4] identified that fibroids, followed by

adenomyosis, were the most common benign lesions in their investigation.

Table 1: This study compares the diagnostic efficacy of MRI and histology for benign and malignant uterine lesions identified by TVS and MRI

	TVS		MRI	
	Benign	Malignant	Benign	Malignant
Sensitivity	95.25%	62%	95.76%	99.98%
Specificity	62.3%	93.55%	100%	96.87%
PPV	80.44%	86.83%	99.78%	97.13%
NPV	84.65%	79.93%	96.13%	100%

Using both TVS and MRI, adenomyosis was diagnosed with 100% accuracy. Pujitha *et al*.[1] noted that both TVS and MRI exhibited 100% sensitivity and specificity in the diagnosis of adenomyosis. Reinhold *et al*.[5] noted comparable diagnostic efficiencies between TVS and MRI, with TVS exhibiting an 84% specificity in their research.

Seven lesions (15.39%) were identified by TVS as endometrial polyps because of their vascular pedicle and regular margin. On MRI and histological confirmation, two cases that TVS had initially misidentified as endometrial polyps were later shown to be endometrial cancer. TVS and MRI both demonstrated 100% sensitivity and 100% specificity in diagnosing endometrial carcinomas based on morphologic features, however TVS had a lower specificity of 95%. This accuracy does not seem to be sufficient to forego histological testing, even though polyps and carcinomas frequently coexist.

On MRI and histological examination, one out of five cases of endometritis identified by TVS turned out to be malignant. Additionally, two fibroid cases that were mistakenly diagnosed as benign tumors on TVS were later determined by MRI and histology to be malignant (one leiomyosarcoma and one cervical cancer).

TVS had an accuracy of 81.56% in interpreting 13 patients out of 50 as malignant and the remaining 37 as benign when compared to histology.

The most frequent benign finding on MRI was adenomyosis (8/50 instances), which was followed by endometrial polyps (9.4%), endometrial hyperplasia, fibroid (14.45%), and endometritis (8.4%). MRI accurately identified the majority of these lesions in accordance with histological analysis. Pujitha *et al*.[1] similarly observed a comparable spectrum of uterine abnormalities in their investigation.

Among malignant uterine lesions, MRI accurately detected all six cases of cervical carcinoma and 12 out of 14 cases of endometrial cancer with a histological diagnosis. Due to overlapping imaging features, two MRI cases of endometrial cancer were later determined to be endometrial hyperplasia on histology.

While both TVS and MRI had 100% specificity for detecting endometrial hyperplasia, TVS had a higher sensitivity than MRI (83% vs. 64.61%). However, Ahmad *et al*.[2] reported that MRI is less sensitive (50%), with 84% specificity, than a research by Mohammad Tharwat *et al*.[6], which found that MRI's sensitivity and specificity were 100% and 94.3%, respectively, for endometrial hyperplasia.

Of the 50 patients in the study, 22 (41.4%) had a malignant MRI, while the remaining 33 (61.6%) had a benign MRI. Our MRI findings were analogous to those of Yadav[8], who reported an overall sensitivity of 100% and a specificity of 96.43% for lesion diagnosis. According to Mohammad Tharwat *et al*.[6], the sensitivity and specificity of MRI were 100% and 82.35%, respectively. Uterine lesions exhibit a variety of characteristics on transvaginal sonography and magnetic resonance imaging.

The primary drawback of the study was the small sample size; with 50 patients, we encompassed the entire spectrum of uterine pathology. Moreover, the study fails to accurately represent the prevalence of uterine pathology, as numerous cases are subjected to hysterectomy without prior MRI assessment.

Everyday practice frequently deals with perimenopausal bleeding, and because it significantly affects women's health, early pathology detection is essential. In perimenopausal age cases of uterine cancer, the survival rate can be considerably increased with early identification alone.

Transvaginal sonography (TVS) demonstrates a sensitivity of 62% and a specificity of 95.25% for malignant uterine lesions, making it an effective main imaging modality. This dynamic imaging method is broadly accessible, inexpensive, and non-invasive. However, TVS experiences inter-observer variation and is not thought to be sufficiently adaptable. False negative results result in the neglect of a deadly disease, whereas false positive results result in needless interventions. The more risky part of an investigative modality is false negatives because the survival probability drastically decreases as the malignant stage progresses. Therefore, the significant false-negative rate of 41.0% seen during evaluation with TVS must be addressed. This requires an improved diagnostic method for a more precise detection of the lesions.

The diagnostic performance of MRI, with a sensitivity of 99.98% and specificity of 95.76%, surpassed that of TVS. The MRI with DWI sequence demonstrated a zero false negative rate, establishing it as the superior option. Its non-invasiveness and lack of radiation exposure danger are further benefits. Additionally, diffusion-weighted imaging eliminates the requirement for intravenous contrast fluid, resulting

in it appropriate for situations where using contrast is contraindicated. It can assist in determining the lesion's location, staging, recurrence, and therapy response. MRI's universal contraindications, limited availability, and cost are its disadvantages.

According to our research, MRI should be taken into account in the evaluation strategy of suspected uterine cancer, particularly in sonographically ambiguous lesions, even though TVS remains the standard imaging modality. A transition of MRI from a problem-solving instrument to a primary management tool is probable.

Key Points:

- On imaging, uterine lesions show a wide range of results. To enhance the prognosis of a malignant lesion, prevent unnecessary intrusive operations, and make a diagnosis or list the differentials, one must be aware of these characteristics.
- TVS and MRI showed significant differences in malignancy diagnosis, mostly due to TVS's inability to identify focal myometrial invasion, minor endometrial abnormalities, and differential enhancement.
- MRI because it can assess tissue properties using many parameters, which are likely to score higher than TVS when evaluating endometrial diseases.

Abbreviations:

- AUB: Abnormal uterine bleeding;
- MRI: Magnetic resonance imaging;
- TVS: Transvaginalultrasonography;
- T1WI: T1-weighted image;
- T2WI:T2-weighted image;
- SPSS: Statistical Package for the Social Science.

Declarations:

- Ethics approval and consent to participate - The study received approval from our institutional ethics committee.
- Consent for publishing: All participants in this study were provided with a comprehensive description of the study's aim, objectives, and methods prior to enrollment. Consent for data publication was obtained from all study participants.
- The datasets utilized and/or analyzed in this investigation are accessible from the corresponding author upon reasonable request. Conflicts of interest: We affirm that we possess no conflicts of interest.
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