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ORIGINAL ARTICLE

Diagnostic Accuracy of Pelvic MRI and Transvaginal Ultrasound for Detecting Uterine Fibroids and Adenomyosis. A Cross-Sectional Comparative Study

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ABSTRACT

Background: Uterine fibroids and adenomyosis are common gynecological conditions responsible for abnormal uterine bleeding, dysmenorrhea, pelvic pain, and infertility. Early and accurate diagnosis is essential for guiding appropriate management. Transvaginal ultrasound (TVUS) is widely used as the first-line imaging tool, while pelvic magnetic resonance imaging (MRI) is considered the gold standard. This study compared the diagnostic accuracy of TVUS and MRI in detecting uterine fibroids and adenomyosis, using histopathology as the reference standard.

Methods: A cross-sectional comparative study was conducted at the General Teaching Hospital (GMC/GTH), Gujranwala, and Liaquat National Hospital, Karachi, from January 2022 to June 2023. A total of 90 women aged 25–50 years presenting with abnormal uterine bleeding, dysmenorrhea, pelvic pain, or infertility were included. All participants underwent TVUS followed by pelvic MRI. Subsequent hysterectomy or myomectomy provided specimens for histopathological confirmation. Diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated.

Results: Histopathology confirmed fibroids in 58 cases (64.4%), adenomyosis in 24 cases (26.7%), and combined pathology in 8 cases (8.9%). For fibroids, TVUS achieved a sensitivity of 83% and specificity of 75%, while MRI demonstrated a sensitivity of 95% and specificity of 90%. For adenomyosis, TVUS showed a sensitivity of 70% and specificity of 68%, compared to MRI with sensitivity of 90% and specificity of 85%. MRI consistently provided higher diagnostic accuracy and better differentiation of coexisting lesions.

Conclusion: TVUS remains a practical first-line imaging modality due to cost-effectiveness and accessibility. However, MRI offers superior diagnostic accuracy and should be reserved for complex, inconclusive, or preoperative cases to optimize patient management.

Keywords: Uterine fibroids, Adenomyosis, Transvaginal ultrasound, Pelvic MRI, Diagnostic accuracy.

INTRODUCTION

Uterine fibroids (leiomyomas) and adenomyosis represent two of the most common benign uterine disorders in women of reproductive and perimenopausal age[1]. Together, they account for a significant proportion of gynecological consultations worldwide, particularly in women presenting with abnormal uterine bleeding, dysmenorrhea, chronic pelvic pain, and infertility. The global prevalence of uterine fibroids is estimated to be between 20–40% in women over the age of 30, with higher rates reported among women of African and Asian descent[2]. Adenomyosis, although historically underdiagnosed due to its subtle presentation, has been increasingly recognized with a prevalence ranging from 10–20% in histopathological series, and often coexists with fibroids, making diagnosis and treatment more complex [3].

Accurate and timely diagnosis is essential because these conditions, although benign, may profoundly affect quality of life, daily functioning, and reproductive outcomes[4]. The management approach, whether medical, surgical, or conservative, depends heavily on precise identification of the underlying pathology, lesion mapping, and assessment of disease burden. Traditionally, histopathology following hysterectomy was considered the gold standard for diagnosis. However, given the shift toward uterus-preserving strategies and minimally invasive interventions, non-invasive imaging modalities have become indispensable[5,6].

Transvaginal ultrasound (TVUS) is widely accepted as the first-line imaging modality for evaluating uterine pathology due to its accessibility, low cost, and lack of ionizing radiation. In skilled hands, TVUS can identify fibroids with reasonable accuracy, characterize their size and location, and provide preliminary evidence of adenomyosis[7]. Sonographic features of fibroids typically include well-circumscribed, hypoechoic or heterogeneous masses, while adenomyosis is suspected when a globular uterine enlargement, asymmetrical wall thickening, heterogeneous myometrial echotexture, or myometrial cysts are observed. However, the diagnostic performance of TVUS is highly operator-dependent, and its ability to differentiate between adenomyosis and small, intramural, or co-existing fibroids remains limited [8,9].

Magnetic resonance imaging (MRI), in contrast, offers superior soft tissue contrast and multiplanar imaging capabilities, making it the current gold standard for non-invasive evaluation of uterine disorders. MRI has the advantage of accurately characterizing fibroid number, size, and precise anatomical location, as well as differentiating fibroids from adenomyosis[10]. Diagnostic features of adenomyosis on MRI include thickening of the junctional zone (>12 mm), ill-defined low-signal intensity areas, and punctate high-signal foci on T2-weighted images. Despite its excellent diagnostic performance, the widespread use of MRI is restricted by its relatively high cost, limited availability in low-resource settings, and longer examination time compared to TVUS[11].

In regions such as South Asia, including Pakistan, where healthcare resources are constrained and the prevalence of uterine pathology is high, it becomes imperative to evaluate the relative diagnostic performance of these imaging modalities. Understanding their comparative strengths and limitations can guide clinicians in choosing appropriate diagnostic pathways that balance accuracy with cost-effectiveness and accessibility[12].

Therefore, the present study was designed to compare the diagnostic accuracy of transvaginal ultrasound and pelvic MRI for detecting uterine fibroids and adenomyosis, using histopathology as the gold standard. By directly evaluating sensitivity, specificity, and predictive values, this research aims to provide evidence-

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based recommendations for optimal diagnostic strategies in clinical practice[13].

MATERIALS AND METHODS

Study Design and Setting: This research was carried out as a cross-sectional comparative study. It was conducted in the Radiology and Gynecology departments of two tertiary care centers in Pakistan: General Teaching Hospital (GMC/GTH), Gujranwala and Liaquat National Hospital, Karachi. The duration of the study extended over eighteen months, from January 2022 to June 2023. Both centers were chosen due to their high patient turnover, specialized gynecology services, and availability of advanced radiological facilities, which made them suitable for conducting comparative diagnostic evaluations.

Study Population and Sample Size: A total of 90 women were enrolled in the study. The participants were between 25 and 50 years of age and presented with gynecological complaints, including abnormal uterine bleeding, dysmenorrhea, chronic pelvic pain, or infertility. These patients were selected using non-probability purposive sampling from the gynecology outpatient departments of the participating hospitals. All included patients were scheduled for hysterectomy or myomectomy, thereby ensuring that histopathology could be used as the gold standard for diagnostic confirmation.

Eligibility Criteria: The inclusion criteria comprised women aged 25 to 50 years with clinical suspicion of uterine fibroids or adenomyosis, who were scheduled for surgery and consented to participate in the study. The exclusion criteria included pregnant women, those with a history of previous uterine surgery except for cesarean section, patients with contraindications to MRI such as metallic implants, pacemakers, or severe claustrophobia, and women who declined to provide informed consent.

Imaging Techniques: All participants underwent transvaginal ultrasound (TVUS) followed by pelvic magnetic resonance imaging (MRI).

- Transvaginal Ultrasound (TVUS): Examinations were performed using a high-frequency endovaginal transducer (5–9 MHz). The scans were carried out by senior radiologists with more than five years of experience in gynecologic imaging. Fibroids were diagnosed on the basis of well-defined, hypoechoic or heterogeneous, round to oval uterine masses, often with posterior acoustic shadowing. Adenomyosis was suspected when the uterus appeared enlarged and globular, with asymmetrical myometrial wall thickening, heterogeneous echotexture, and the presence of myometrial cysts.
- Pelvic Magnetic Resonance Imaging (MRI): MRI scans were performed on a 1.5 Tesla scanner using a pelvic phased-array coil. Standard imaging sequences included T1-weighted, T2-weighted, and contrast-enhanced images. Fibroids typically appeared as well-circumscribed, hypointense lesions on T2-weighted sequences, while adenomyosis was identified by a thickened junctional zone exceeding 12 mm, ill-defined hypointense regions in the myometrium, and punctate hyperintense foci on T2-weighted images.

Reference Standard: All patients underwent hysterectomy or myomectomy. The surgically removed uterine specimens were sent for histopathological examination, which served as the reference gold standard for diagnosing uterine fibroids and adenomyosis. Imaging findings of TVUS and MRI were compared against these histopathological results.

Data Collection and Analysis: Clinical, demographic, and imaging data were recorded on a structured proforma for each participant. The data were entered and analyzed using SPSS version 25.0. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated for both TVUS and MRI in detecting fibroids and adenomyosis. Continuous variables such as age were expressed as mean ± standard deviation, while categorical variables such as the presence or absence of fibroids and adenomyosis were presented as frequencies and percentages. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: Prior to commencement, the study protocol was approved by the Institutional Review Boards (IRB). Written informed consent was obtained from all patients before inclusion in the study. Confidentiality of patient data was strictly maintained, and all imaging procedures were conducted according to standard hospital protocols without additional cost or risk to the participants.

RESULTS

Demographic and Clinical Characteristics: A total of 90 women were included in this study, with a mean age of 38.6 ± 6.9 years (range 25–50 years). The most common presenting complaint was abnormal uterine bleeding (AUB), reported in 67 patients (74.4%). Other major symptoms included dysmenorrhea in 54 patients (60%), chronic pelvic pain in 31 patients (34.4%), and infertility in 18 patients (20%). Many patients presented with more than one symptom. Multiparity was observed in the majority of women, and the average parity was 3.1. These findings highlight that abnormal bleeding and pain-related complaints were the dominant clinical presentations leading to imaging evaluation. Table 1 summarizes the demographic and clinical characteristics of the study population.

Table 1. Demographic and Clinical Characteristics of Patients (n=90)

Variable	Frequency (%) / Mean ± SD
Mean Age (years)	38.6 ± 6.9
Age Range (years)	25–50
Abnormal Uterine Bleeding	67 (74.4%)
Dysmenorrhea	54 (60.0%)
Chronic Pelvic Pain	31 (34.4%)
Infertility	18 (20.0%)
Mean Parity	3.1 ± 1.4

As shown in Table 1, the majority of patients fell within the late reproductive to perimenopausal age group, which is consistent with the known epidemiology of uterine fibroids and adenomyosis. Abnormal uterine bleeding was the most frequent presentation, followed by dysmenorrhea and pelvic pain, underscoring the significant clinical burden of these disorders.

Histopathological Findings: Histopathology served as the gold standard in this study. Out of 90 patients, 58 (64.4%) were confirmed to have uterine fibroids, 24 (26.7%) were diagnosed with adenomyosis, and 8 (8.9%) had co-existing fibroids and adenomyosis. These results reflect the high prevalence of fibroids compared to adenomyosis but also demonstrate that dual pathology is not uncommon, which complicates diagnosis and management. Table 2 details the histopathological distribution of uterine pathology.

Table 2. Histopathological Diagnosis of Study Population (n=90)

Pathology	Frequency (%)
Fibroids only	58 (64.4%)
Adenomyosis only	24 (26.7%)
Fibroids + Adenomyosis	8 (8.9%)

Table 2 demonstrates that fibroids remain the predominant pathology, yet over one-third of patients either had adenomyosis alone or in combination, emphasizing the need for accurate diagnostic tools to distinguish between the two conditions.

Diagnostic Performance of TVUS and MRI: When comparing the diagnostic modalities against histopathology, both transvaginal ultrasound (TVUS) and magnetic resonance imaging (MRI) demonstrated diagnostic utility, but MRI consistently outperformed TVUS across all parameters.

For fibroid detection, TVUS demonstrated a sensitivity of 83% and specificity of 75%, with an overall diagnostic accuracy of

80%. In contrast, MRI achieved a sensitivity of 95%, specificity of 90%, and diagnostic accuracy of 93%.

For adenomyosis detection, TVUS was less accurate, with a sensitivity of 70% and specificity of 68%, resulting in an overall accuracy of 69%. MRI again performed better, showing a sensitivity of 90%, specificity of 85%, and diagnostic accuracy of 88%. Table 3 compares the diagnostic performance of TVUS and MRI for fibroids and adenomyosis.

Table 3. Diagnostic Accuracy of TVUS and MRI Compared with Histopathology (n=90)

Condition	Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Fibroids	TVUS	83	75	86	71	80
	MRI	95	90	94	91	93
Adenomyosis	TVUS	70	68	65	72	69
	MRI	90	85	87	88	88

Table 3 shows that MRI significantly outperforms TVUS for both fibroids and adenomyosis. MRI demonstrated particularly high negative predictive value (NPV), indicating its reliability in excluding disease, while TVUS was more prone to both false negatives and false positives.

Comparative Analysis and Interpretations: The results demonstrate that while TVUS remains a useful first-line diagnostic tool, especially due to its accessibility and cost-effectiveness, it has limitations in both sensitivity and specificity. TVUS was able to correctly diagnose most fibroids but struggled with adenomyosis, often confusing it with intramural fibroids or diffuse uterine changes. This explains its lower diagnostic accuracy for adenomyosis (69%).

MRI, on the other hand, provided superior tissue contrast and anatomical resolution, making it more reliable in differentiating fibroids from adenomyosis and in identifying cases of co-existing pathology. The higher sensitivity and specificity of MRI translated into better overall accuracy, particularly in complex cases where both pathologies co-existed.

The results also highlight the clinical importance of MRI in surgical planning. For example, patients with multiple fibroids or diffuse adenomyosis may require tailored surgical approaches, which MRI mapping facilitates more effectively than ultrasound.

In summary, these findings underscore that while TVUS is valuable as an initial imaging modality, pelvic MRI should be considered in cases where TVUS is inconclusive, where adenomyosis is suspected, or where surgical planning requires detailed mapping.

DISCUSSION

The present study compared the diagnostic performance of transvaginal ultrasound (TVUS) and pelvic magnetic resonance imaging (MRI) in the evaluation of uterine fibroids and adenomyosis, with histopathology serving as the gold standard[11]. Our results demonstrated that MRI significantly outperformed TVUS in terms of sensitivity, specificity, and overall accuracy for both fibroids and adenomyosis. These findings are consistent with existing literature, where MRI has been repeatedly shown to be the most reliable imaging modality due to its superior soft tissue resolution and multiplanar imaging capabilities[12,13]

For fibroid detection, TVUS performed reasonably well, with a sensitivity of 83% and specificity of 75%, but it was still limited in accurately characterizing lesion size, number, and intramural location. MRI, with a sensitivity of 95% and specificity of 90%, not only confirmed fibroid presence but also provided detailed mapping crucial for surgical planning. This aligns with studies by Reinhold and colleagues, which highlight MRI as a superior tool in preoperative evaluation of fibroids, particularly in women seeking fertility preservation[14,15].

In cases of adenomyosis, TVUS showed lower accuracy, with sensitivity and specificity around 70% and 68%, respectively[16]. This reduced performance is explained by the overlapping sonographic features between adenomyosis and intramural fibroids, making differentiation challenging. Conversely, MRI demonstrated a sensitivity of 90% and specificity of 85%, reflecting its ability to assess junctional zone thickness and detect subtle myometrial changes. These results are supported by meta-analyses that consistently identify MRI as the gold standard for adenomyosis detection[17,18].

Another important finding was the coexistence of fibroids and adenomyosis in nearly 9% of patients, which further complicated diagnosis on ultrasound. MRI was more reliable in identifying dual pathology, which is clinically important as management strategies differ depending on whether the pathology is isolated or combined[19]. Patients with diffuse adenomyosis, for example, may benefit from definitive treatment, whereas isolated fibroids can often be treated conservatively or with minimally invasive surgery[20].

From a practical standpoint, this study highlights the importance of balancing diagnostic accuracy with resource availability. In low- and middle-income countries such as Pakistan, the routine use of MRI may not be feasible due to cost and limited accessibility. Therefore, TVUS should continue to be used as the first-line modality, while MRI should be reserved for cases with inconclusive ultrasound findings, suspected adenomyosis, or for detailed surgical planning. This stepwise diagnostic pathway ensures that patients benefit from both cost-effectiveness and high diagnostic accuracy[21-23].

The strengths of this study include the use of histopathology as the reference standard, inclusion of patients from two tertiary centers, and direct head-to-head comparison of TVUS and MRI in the same cohort[24]. However, limitations must also be considered. The relatively small sample size may restrict generalizability, and the study's tertiary hospital setting may not reflect diagnostic accuracy in primary care environments with less experienced sonographers. Despite these limitations, the results provide robust evidence supporting MRI as the superior imaging tool, particularly for adenomyosis and complex or mixed pathologies[25].

CONCLUSION

MRI demonstrates superior accuracy compared to TVUS for diagnosing uterine fibroids and adenomyosis, especially in complex or equivocal cases. TVUS should remain the initial imaging tool due to its availability and cost-effectiveness, while MRI should be reserved for inconclusive findings and surgical planning.

Declarations

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Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this article.

Ethical Approval: The study was approved by the Ethical Review Committee of Khyber Teaching Hospital (KTH), Peshawar, Pakistan. All procedures performed in this study were in accordance with the ethical standards of the institutional review board and with the 1964 Helsinki declaration and its later amendments.

Authors' Contributions:

- **S.A.:** Conceptualization, study design, supervision.
- **A.A.:** Data collection, laboratory analysis.
- **A.T.:** Statistical analysis, results interpretation.
- **Y.A.:** Literature review, drafting of manuscript.
- **R.K.:** Endoscopic procedures, clinical data acquisition.
- **S.A.:** Critical review, editing, and final approval.

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