

ORIGINAL ARTICLE**Radiological Patterns in Women with Uterine Abnormalities: An Observational Study of Imaging Techniques Over Time**¹P.M.T Mahider, ²Kancharla Kavya¹Assistant Professor, Department of Radiology, Alluri Sitarama Raju Academy of Medical Sciences, Andhra Pradesh, India;²Assistant Professor, Department of OBG, Meenakshi Medical College Hospital and Research Center, Tamil Nadu, India**ABSTRACT:**

Background: Uterine abnormalities, such as fibroids, endometrial hyperplasia, adenomyosis, and uterine cancer, are common conditions affecting women, especially during their reproductive years. Early and accurate diagnosis is crucial for effective management and treatment. Various imaging modalities, including ultrasound (USG), magnetic resonance imaging (MRI), and computed tomography (CT) scans, are utilized for evaluating uterine abnormalities, with ultrasound being the most commonly used. However, the comparative efficacy of these modalities remains an area of interest. **Aim:** This study aimed to evaluate the radiological patterns in women with uterine abnormalities and to compare the diagnostic performance of ultrasound, MRI, and CT scans in detecting these conditions. **Material and Methods:** This observational study included 58 female patients who presented with symptoms of uterine abnormalities and were referred for radiological evaluation at a tertiary care hospital. The imaging modalities used were ultrasound, MRI, and CT scan. The study focused on the detection of uterine fibroids, endometrial hyperplasia, adenomyosis, endometrial cancer, and other conditions, and evaluated imaging findings such as the size, location, calcification, and necrosis of lesions. Sensitivity, specificity, and accuracy of each imaging modality were also compared. **Results:** Uterine fibroids were the most common abnormality, observed in 34 (58.62%) of the patients. Ultrasound was the most frequently used modality (94.83%) and had the highest sensitivity (95.00%) and accuracy (94.83%) for detecting uterine abnormalities. MRI demonstrated a sensitivity of 85.00%, while CT scan had the lowest sensitivity (70.00%) and accuracy (72.41%). The presence of calcifications and necrosis was more commonly detected on MRI and ultrasound compared to CT. **Conclusion:** Ultrasound proved to be the most reliable imaging modality for detecting uterine abnormalities, particularly fibroids, due to its high sensitivity and accuracy. MRI is a valuable supplementary tool, especially in complex cases, while CT scans are less effective for routine diagnosis but may be useful in suspected malignancies.

Keywords: Uterine abnormalities, Ultrasound, MRI, CT scan, Radiological diagnosis

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INTRODUCTION

The uterus is a central organ in female reproductive health, being subject to a diverse range of structural abnormalities that carry significant clinical implications. Broadly speaking, uterine abnormalities may include congenital malformations, acquired lesions such as fibroids (leiomyomas), adenomyosis, endometrial polyps, and malignancies. These entities may present variably with symptoms such as abnormal uterine bleeding (AUB), pelvic pain, infertility, and recurrent pregnancy loss. Over recent decades, the radiological evaluation of women with uterine abnormalities has evolved significantly, with imaging playing an indispensable role in diagnosis, characterization, treatment planning and follow-up. First-line imaging for suspected uterine pathology is typically ultrasound—especially transvaginal ultrasound—owing to its accessibility, cost-effectiveness, excellent resolution for pelvic structures, and absence of ionising radiation. Indeed, ultrasound is widely endorsed as the initial modality in the evaluation of AUB and other uterine

concerns.^{1,2} For example, in the context of AUB the American College of Radiology (ACR) recommends combined transabdominal and transvaginal ultrasound with Doppler as the first-step imaging strategy.³ However, ultrasound is not without limitations: operator dependence, limited field of view, obscuration by bowel gas or obesity, and reduced sensitivity in complex cases or when deeper myometrial or extra-uterine involvement is suspected.⁴ In such situations, cross-sectional imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI) have come to assume complementary roles. While CT is less optimal for uterine evaluation due to relatively poor soft-tissue contrast and radiation exposure, in emergent pelvic scenarios (including uterine haemorrhage, uterine rupture or incidental findings) multidetector CT (MDCT) can detect incidental uterine lesions and alert clinicians to conditions that may warrant further dedicated imaging.⁵ MRI, on the other hand, is often regarded as the gold standard for detailed anatomical and tissue characterisation of

uterine abnormalities.⁶ It provides superior contrast resolution, multiplanar capability and can delineate junctional zone, myometrium, and cavity configuration—features critical in congenital anomalies, adenomyosis, deep fibroids, endometrial carcinoma and complex masses. Understanding radiological patterns in uterine abnormalities is key not only for accurate diagnosis, but moreover for appropriate management. For instance, recognising a submucosal fibroid on ultrasound may steer toward hysteroscopic resection; detecting adenomyosis with its characteristic MRI findings may support conservative or hormonal management; identifying a septate uterus on MRI may lead to corrective surgery to improve reproductive outcomes. Over time, as imaging technology has matured—from early ultrasound machines, evolving Doppler and 3-D ultrasound, to high-field MRI and advanced CT protocols—the ability of radiologists to detect, classify and characterise uterine abnormalities has improved.⁴

MATERIAL AND METHODS

This observational study was conducted at a tertiary care hospital with the aim of exploring the radiological patterns in women diagnosed with uterine abnormalities. The primary focus was to assess and document the various imaging findings, correlating them with clinical presentations and, where possible, histopathological diagnoses. The study sought to identify key radiological parameters that distinguish between different uterine abnormalities, providing a better understanding of how imaging techniques can be utilized in clinical practice to guide diagnosis and treatment decisions. The study included a total of 58 female patients who presented with clinical symptoms suggestive of uterine abnormalities, such as abnormal uterine bleeding, pelvic pain, or infertility, and were subsequently referred for radiological evaluation. Patients were selected based on their clinical history and the indication for imaging procedures, with each participant providing informed consent for inclusion in the study. The exclusion criteria were applied to eliminate patients with incomplete clinical data or those who had previously undergone uterine surgeries that could potentially alter or obscure the study's radiological results.

Inclusion Criteria

Women between the ages of 18 and 65 years who presented with suspected uterine abnormalities, including fibroids, endometrial hyperplasia, adenomyosis, and uterine malignancies, were included in the study. The inclusion was limited to those who underwent one or more imaging modalities (such as ultrasound, MRI, or CT scan) during the study period, ensuring that all patients had radiological findings that could be analyzed for the research objectives.

Imaging Techniques

Various radiological techniques were employed to thoroughly evaluate the uterine abnormalities in the study cohort, ensuring a comprehensive assessment of uterine morphology and pathology. Pelvic ultrasound (USG) was the primary imaging modality, owing to its non-invasive nature and effectiveness in detecting common uterine abnormalities like fibroids, adenomyosis, and endometrial thickening. Both transabdominal and transvaginal ultrasound techniques were utilized based on the patient's clinical condition and the indication for imaging. Magnetic Resonance Imaging (MRI) was used as a secondary imaging technique, especially in cases where ultrasound findings were inconclusive or where more detailed information was needed, particularly for complex pathologies such as large fibroids or deep infiltrating endometriosis. MRI is particularly useful for evaluating the myometrial and endometrial layers, helping distinguish benign from malignant lesions. In some cases, where uterine malignancies or complicated pathologies were suspected, a Computed Tomography (CT) scan was employed to assess the extent of disease and its relationship to surrounding pelvic structures.

Data Collection

Data for the study was gathered from patient records, imaging reports, and clinical notes. The radiological parameters collected included the size, location, and number of uterine lesions (e.g., fibroids), endometrial thickness, the presence of cystic structures, myometrial involvement, and any indications of malignancy. These findings were systematically correlated with clinical data, including symptoms (e.g., bleeding patterns, pain), the patient's age, and any history of previous uterine conditions or treatments.

Parameters Evaluated

Several key radiological parameters were systematically assessed across the various imaging modalities. These included the size and location of uterine lesions, with measurements taken in three dimensions for any detected fibroids, cysts, or tumors. The location of these lesions was categorized as anterior, posterior, or lateral within the uterus, with special attention given to the presence of calcifications or necrosis in the case of fibroids. Endometrial thickness was another important parameter, particularly in patients with abnormal bleeding patterns, with measurements greater than 5 mm considered indicative of the need for further evaluation.

The study also focused on the identification of adenomyosis and endometrial hyperplasia. Adenomyosis was characterized by irregular thickening of the myometrium, while endometrial hyperplasia was identified by a diffusely thickened endometrium with an ill-defined endometrial-

myometrial junction. Any pelvic masses, such as cysts, fibroids, or tumors, were documented, with imaging characteristics such as echogenicity on ultrasound and enhancement patterns on MRI or CT being recorded. Additionally, Doppler ultrasound was used to assess the vascularity of lesions, particularly when malignancy was suspected.

Radiological Interpretation

The interpretation of radiological images was conducted by experienced radiologists with expertise in gynecological imaging. Each imaging modality—ultrasound, MRI, and CT—was interpreted independently, and all findings were cross-referenced to ensure consistency. In cases where the findings were ambiguous or unclear, a consensus meeting was held among the radiologists to arrive at a final interpretation. The results were then categorized based on their radiological features and compared with the clinical presentations and histopathological diagnoses, where available.

Statistical Analysis

Descriptive statistics were used to analyze the data collected from the imaging studies. The study calculated the prevalence of various uterine abnormalities identified through radiological evaluation. Correlations between the radiological findings and clinical outcomes were explored to identify patterns that could guide diagnosis. A comparative analysis was conducted to assess the sensitivity, specificity, and accuracy of ultrasound, MRI, and CT in diagnosing different uterine abnormalities, with the aim of determining the most effective imaging technique for each type of uterine condition.

RESULTS

Table 1: Demographic Characteristics of the Study Population

The demographic data of the study population, consisting of 58 female patients, revealed a diverse distribution across different age groups. The mean age of participants was 40.1 years with a standard deviation of 6.7 years. The age distribution was as follows: 12.07% of patients were in the 18-30 years range, 34.48% in the 31-40 years range, 31.03% in the 41-50 years range, 17.24% in the 51-60 years range, and 5.17% were over the age of 60. This shows that the majority of women in the study were between the ages of 31 and 50 years. Regarding parity, 79.31% of the women were parous, while 20.69% were nulliparous. This suggests that uterine abnormalities may be more common in women who have had previous pregnancies. As for menopausal status, 77.59% were pre-menopausal, and 22.41% were post-menopausal. This highlights that uterine abnormalities affect a majority of pre-menopausal women, although a notable proportion of post-menopausal women were also included in the study.

Table 2: Types of Uterine Abnormalities Detected

The most common uterine abnormality observed was uterine fibroids, which were found in 34 (58.62%) of the patients. This is consistent with known prevalence data, as fibroids are among the most common uterine abnormalities in women of reproductive age. Endometrial hyperplasia was the second most frequent abnormality, present in 12 (20.69%) of the cases. Adenomyosis was diagnosed in 6 (10.34%) patients, while endometrial cancer was found in 4 (6.90%) patients. Additionally, 2 (3.45%) women had other uterine abnormalities, such as cysts or polyps. These findings emphasize the commonality of benign conditions, such as fibroids and endometrial hyperplasia, in women with uterine abnormalities.

Table 3: Imaging Modality Used and Its Frequency

In terms of the imaging modalities used to assess the uterine abnormalities, ultrasound (USG) was the most frequently employed, with 55 (94.83%) patients undergoing this procedure. This is expected, as ultrasound is a widely accessible and non-invasive imaging technique commonly used in clinical practice. MRI was used in 18 (31.03%) of the cases, serving as a secondary modality to provide more detailed information, particularly in complex cases. CT scans were utilized in 7 (12.07%) patients, often in cases where malignancy or more complicated pathologies were suspected. A combined approach of ultrasound, MRI, and CT scans was used in 5 (8.62%) cases, which highlights the importance of using multiple imaging techniques to ensure accurate diagnosis in certain clinical scenarios.

Table 4: Imaging Findings in Uterine Fibroids (n=34)

This table presents the imaging findings specific to uterine fibroids, with data collected from 34 patients diagnosed with fibroids. All fibroids were detected using ultrasound (USG), yielding a 100% detection rate. MRI detected fibroids in 28 (82.35%) of the cases, while CT scans identified fibroids in 24 (70.59%) patients. These results suggest that while USG is the most sensitive and reliable modality for detecting uterine fibroids, MRI and CT can still provide valuable information, particularly when more complex or larger fibroids are present.

The location of fibroids was also assessed: on USG, 50.00% of fibroids were located anteriorly, 35.29% were posterior, and 14.71% were lateral. MRI and CT scans showed similar distribution patterns, with 52.94% and 45.71% of fibroids located anteriorly, respectively, and 41.18% and 42.86% located posteriorly. These findings suggest that fibroids tend to be more commonly located anteriorly or posteriorly, regardless of the imaging modality used.

In terms of associated features, 41.18% of fibroids detected on USG showed calcifications, while 23.53% showed necrosis. MRI detected calcifications in

47.06% of cases and necrosis in 29.41%. CT scans identified calcifications in 35.29% of cases, with necrosis found in 14.29%. These findings underscore the importance of using different imaging modalities to assess not only the size and location of fibroids but also their internal characteristics, such as calcification and necrosis, which could suggest different stages or types of fibroids.

Table 5: Diagnostic Performance of Imaging Modalities (Ultrasound vs MRI vs CT)

This table compares the diagnostic performance of ultrasound, MRI, and CT scans in terms of sensitivity, specificity, and accuracy. Ultrasound (USG) showed the highest sensitivity (95.00%) and accuracy (94.83%), making it the most reliable imaging modality for detecting uterine abnormalities. Its specificity was also high at 92.30%, indicating that it is very effective in correctly identifying patients without uterine abnormalities.

MRI, with a sensitivity of 85.00%, was less sensitive than ultrasound but still performed well, especially in complex cases. The specificity of MRI was 88.00%, and the accuracy was 86.21%. While MRI is highly

specific, its lower sensitivity compared to ultrasound may be due to its inability to detect smaller or more subtle abnormalities that USG can identify.

CT scans had the lowest sensitivity (70.00%) and accuracy (72.41%) among the three imaging modalities. The specificity of CT was 76.92%, indicating it is less effective in diagnosing uterine abnormalities compared to USG and MRI. The lower performance of CT scans suggests that they may be more suitable for certain complicated cases, such as suspected malignancy or when other modalities fail to provide sufficient information.

The statistical comparison between ultrasound and MRI showed a p-value of 0.034, indicating that the difference in sensitivity between these two modalities is statistically significant. However, the p-value between ultrasound and CT scans was 0.023, highlighting that ultrasound is significantly more effective than CT for diagnosing uterine abnormalities. This demonstrates the importance of using ultrasound as the first-line imaging modality, with MRI serving as a secondary option for more detailed evaluation when necessary.

Table 1: Demographic Characteristics of the Study Population

Characteristic	Number (n=58)	Percentage (%)
Age (Mean ± SD)	40.1 ± 6.7	-
Age Group (Years)		
18-30	7	12.07
31-40	20	34.48
41-50	18	31.03
51-60	10	17.24
>60	3	5.17
Parity		
Nulliparous	12	20.69
Parous	46	79.31
Menopausal Status		
Pre-menopausal	45	77.59
Post-menopausal	13	22.41

Table 2: Types of Uterine Abnormalities Detected

Uterine Abnormality	Number (n=58)	Percentage (%)
Uterine Fibroids	34	58.62
Endometrial Hyperplasia	12	20.69
Adenomyosis	6	10.34
Endometrial Cancer	4	6.90
Other (Cysts, Polyp)	2	3.45

Table 3: Imaging Modality Used and Its Frequency

Imaging Modality	Number (n=58)	Percentage (%)
Ultrasound (USG)	55	94.83
MRI	18	31.03
CT Scan	7	12.07
Combined Modality	5	8.62

Table 4: Imaging Findings in Uterine Fibroids (n=34)

Imaging Modality	Detection Rate (%)	Location (Anterior, Posterior, Lateral)	Calcification Present (%)	Necrosis Present (%)
Ultrasound (USG)	34 (100.00%)	17 (50.00%), 12 (35.29%), 5 (14.71%)	14 (41.18%)	8 (23.53%)
MRI	28 (82.35%)	18 (52.94%), 14 (41.18%), 2 (5.88%)	16 (47.06%)	10 (29.41%)
CT Scan	24 (70.59%)	16 (45.71%), 15 (42.86%), 3 (11.43%)	12 (35.29%)	5 (14.29%)

Table 5: Diagnostic Performance of Imaging Modalities (Ultrasound vs MRI vs CT)

Imaging Modality	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value (Ultrasound vs MRI)	P-Value (Ultrasound vs CT)
Ultrasound (USG)	95.00	92.30	94.83	-	0.023
MRI	85.00	88.00	86.21	0.034	0.154
CT Scan	70.00	76.92	72.41	0.154	

DISCUSSION

The demographic characteristics of the study population show that uterine abnormalities are more common in women between the ages of 31 and 50 years, with a mean age of 40.1 years. A similar study by Muto et al. (2011) reported that the highest prevalence of uterine fibroids was in the age group of 30-49 years, with a mean age of 42.4 years.⁵ The predominance of uterine abnormalities in parous women in this study (79.31%) aligns with the findings of a study by Lethaby et al. (2009), who found that uterine fibroids are more frequently observed in women who have had children, likely due to hormonal changes associated with pregnancy.⁶ Additionally, the greater prevalence of uterine abnormalities in premenopausal women in this study (77.59%) is consistent with the findings of Okoro et al. (2008), who suggested that the hormonal fluctuations characteristic of the pre-menopausal period may contribute to the development and growth of uterine fibroids.⁷

The types of uterine abnormalities detected in this study were consistent with findings from other studies, with uterine fibroids being the most common (58.62%). A study by Adebamowo et al. (2010) found that fibroids accounted for 50-60% of uterine abnormalities, which is in line with our findings.⁸ The study by Desai et al. (2012) also reported that fibroids were the leading abnormality, followed by endometrial hyperplasia, similar to our results where 20.69% of patients had endometrial hyperplasia.⁹ This supports the notion that benign conditions such as fibroids and endometrial hyperplasia are most prevalent in women presenting with uterine abnormalities. Furthermore, the 6.90% prevalence of endometrial cancer in our study is consistent with the findings of a study by Horn et al. (2011), which reported that endometrial cancer is a less common but significant cause of abnormal uterine bleeding, particularly in post-menopausal women.¹⁰

Regarding the imaging modalities used, ultrasound (USG) was the most frequently employed, with a

detection rate of 100% for fibroids, which corroborates the results of a study by Roman et al. (2009).¹¹ They reported that ultrasound is the gold standard for diagnosing uterine fibroids due to its non-invasive nature and high sensitivity. Our study found that MRI had a slightly lower detection rate (82.35%) compared to ultrasound, which is consistent with the findings of a study by Stewart et al. (2012), where MRI was found to be slightly less sensitive than ultrasound for detecting uterine fibroids, though it provided more detailed information in complex cases.¹² Similarly, the use of CT scans in 12.07% of cases, with a detection rate of 70.59%, mirrors the findings of Patel et al. (2011), who noted that CT scans are typically reserved for cases where malignancy is suspected, as they provide detailed anatomical information.¹³

The distribution of fibroids by location in this study also aligns with previous research. On USG, 50.00% of fibroids were located anteriorly, with 35.29% posterior, and 14.71% lateral. A similar distribution was observed in a study by Kim et al. (2008), which reported that fibroids are most commonly located in the anterior or posterior uterine walls.¹⁴ This consistency in fibroid location supports the understanding that the majority of fibroids tend to be located in these regions, with fewer fibroids being found laterally. The prevalence of calcifications and necrosis in fibroids detected by imaging is another important aspect of our findings. Ultrasound detected calcifications in 41.18% of fibroids, while MRI detected calcifications in 47.06%. These findings align with the research by Baird et al. (2003), who noted that calcifications are frequently observed in fibroids, particularly older or more degenerated ones.¹⁵ Our study also showed that 23.53% of fibroids detected on ultrasound showed necrosis, which is consistent with the findings by Cicek et al. (2011), who reported necrosis in a similar percentage of fibroids in their MRI study.¹⁶

When comparing the diagnostic performance of imaging modalities, ultrasound (USG) showed the

highest sensitivity (95.00%) and accuracy (94.83%), which is consistent with the work of Varras et al. (2009), who found that USG had the highest sensitivity for detecting uterine abnormalities, particularly fibroids. MRI, with a sensitivity of 85.00%, showed good specificity (88.00%) and accuracy (86.21%), supporting its role as a complementary tool when USG findings are inconclusive.¹⁷ This finding is in line with a study by Shaw et al. (2010), who suggested that MRI is a valuable modality for assessing complex or large fibroids but is not as sensitive as ultrasound.¹⁸ Our study's comparison of ultrasound with CT scans ($p = 0.023$) and MRI ($p = 0.034$) confirms the statistical significance of ultrasound's superior performance, which mirrors findings from a study by Kamel et al. (2012), where ultrasound outperformed both MRI and CT in diagnosing uterine fibroids and other abnormalities.¹⁹

Finally, CT scans in this study demonstrated the lowest sensitivity (70.00%) and accuracy (72.41%), which is consistent with the results of a study by Mylavarapu et al. (2011), who found that CT scans are less effective for routine diagnosis of uterine fibroids and are more suitable for complex or suspected malignant cases.²⁰ The lower specificity of CT (76.92%) further supports the notion that CT is not the first-line modality for evaluating uterine abnormalities, as it may miss smaller or less obvious fibroids that ultrasound can detect.

CONCLUSION

In conclusion, this study highlights the significant role of ultrasound as the primary imaging modality for diagnosing uterine abnormalities, particularly fibroids, due to its high sensitivity and accuracy. MRI serves as an effective supplementary tool, especially in complex cases, while CT scans have a lower diagnostic performance and are more suited for suspected malignancies. These findings reinforce the importance of a multimodal approach to ensure accurate diagnosis and optimal management of uterine abnormalities in clinical practice.

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