Research Article

Role of Magnetic Resonance Imaging in The Evaluation of Female Genital Tract Pathologies: A Prospective Cross-Sectional Study With Histopathological Correlation

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Abstract

Background

Female genital tract disorders encompass a broad spectrum of congenital, benign, inflammatory, and malignant conditions that frequently present with overlapping clinical manifestations. Although ultrasonography remains the initial imaging modality, Magnetic Resonance Imaging (MRI) offers superior soft-tissue contrast, multiplanar capability, and excellent lesion characterization, making it the preferred imaging modality for comprehensive pelvic evaluation.

Objective

To evaluate the role of magnetic resonance imaging in the diagnosis and characterization of female genital tract pathologies and to compare MRI findings with histopathological diagnosis or clinical follow-up whenever available.

Materials and Methods

A prospective cross-sectional study was conducted in the Department of Radiodiagnosis, VMKV MCH Salem Tamilnadu. One hundred female patients referred for MRI evaluation of suspected gynecological diseases were included. Pelvic MRI was performed using a 1.5-Tesla Siemens MRI system with standard pelvic imaging protocol, including T1-weighted, T2-weighted, diffusion-weighted imaging (DWI), ADC mapping, susceptibility-weighted imaging (SWI), and contrast-enhanced sequences following intravenous gadolinium administration. MRI findings were correlated with histopathological diagnosis whenever available and with clinical diagnosis and treatment response in remaining cases.

Results

Among 100 patients, the highest proportion belonged to the 31–40 years age group (30%). Cervical carcinoma was the most common pathology (16%), followed by endometrial carcinoma (13%), uterine fibroids (12%), ovarian carcinoma (11%), ovarian cystic lesions (10%), adenomyosis (7%), congenital anomalies (7%), miscellaneous lesions (7%), endometriosis (5%), uterine polyps (4%), while MRI findings were normal in 11% of patients.

Lower abdominal pain (44.3%) was the commonest presenting complaint followed by abnormal uterine bleeding (28.4%), anorexia (22.1%), weight loss (22.1%), pregnancy failure (17.6%) and vaginal discharge (9.6%).

Among uterine fibroids, intramural fibroids constituted 50% of cases. Of the ovarian lesions, 75% were benign whereas 25% were malignant. Among malignant female genital tract neoplasms, cervical carcinoma accounted for 40%, endometrial carcinoma for 32.5%, and ovarian carcinoma for 27.5%.

MRI demonstrated excellent lesion characterization, precise anatomical localization, accurate staging of malignant lesions, and superior assessment of lesion extent and tissue characterization.

Conclusion

MRI is an excellent comprehensive imaging modality for evaluating female genital tract diseases owing to its superior soft tissue

contrast, multiplanar capability, and high diagnostic accuracy. It provides reliable differentiation between benign and malignant lesions, accurately evaluates congenital anomalies, facilitates staging of gynecological malignancies, and significantly contributes to treatment planning.

Keywords: Magnetic Resonance Imaging, Female genital tract, Pelvic MRI, Cervical carcinoma, Ovarian lesions, Endometrial carcinoma, Adenomyosis, Fibroids.

Introduction

Female genital tract diseases represent one of the leading causes of gynecological morbidity worldwide. These disorders include congenital anomalies, inflammatory conditions, benign neoplasms, premalignant lesions, and gynecological malignancies, all of which contribute substantially to infertility, abnormal uterine bleeding, chronic pelvic pain, menstrual disturbances, recurrent pregnancy loss, and cancer-related mortality. Because many of these conditions present with overlapping clinical symptoms, accurate imaging plays a pivotal role in establishing the diagnosis and guiding appropriate management.

Ultrasonography (USG) remains the first-line imaging modality because of its wide availability, low cost, and absence of ionizing radiation. However, ultrasound has several limitations, including operator dependency, restricted field of view, reduced tissue characterization, and difficulty in evaluating deep pelvic structures or complex pelvic masses.

Magnetic Resonance Imaging (MRI) has emerged as the imaging modality of choice for comprehensive evaluation of female pelvic pathology because of its excellent soft tissue contrast, multiplanar imaging capability, and superior anatomical resolution. MRI enables detailed assessment of the uterus, cervix, ovaries, adnexa, vagina, pelvic floor, and surrounding pelvic structures. It accurately characterizes congenital uterine anomalies, differentiates benign from malignant lesions, evaluates tumor extent, determines local invasion, detects lymph node involvement, and assists in treatment planning.

Advanced MRI techniques, including diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, dynamic contrast-enhanced imaging, and fat-suppressed sequences, have further improved lesion characterization and diagnostic confidence. MRI also plays an indispensable role in preoperative staging of gynecological malignancies, monitoring treatment response, and postoperative follow-up.

Despite these advantages, the utilization of MRI in routine evaluation of female genital tract disorders continues to vary across healthcare settings. Therefore, the present study was undertaken to evaluate the spectrum of female genital tract pathologies detected on MRI and to assess its diagnostic accuracy by correlating imaging findings with histopathological diagnosis or clinical follow-up.

Materials and Methods

Study Design

This was a prospective cross-sectional observational study conducted to evaluate the diagnostic role of Magnetic Resonance Imaging (MRI) in female genital tract pathologies and to correlate MRI findings with histopathological diagnosis or clinical follow-up whenever available.

Study Setting

The study was carried out in the Department of Radiodiagnosis, VMKV MCH Salem Tamilnadu India.

Study Population

The study included female patients of all age groups referred to the Department of Radiodiagnosis for pelvic MRI evaluation due to suspected gynecological pathology.

Sample Size
A total of 100 consecutive female patients fulfilling the inclusion criteria were enrolled during the study period.

Inclusion Criteria
Patients satisfying all of the following criteria were included:

- Female patients of any age referred for pelvic MRI because of suspected gynecological disease.
- Patients willing to participate in the study.
- Patients who provided written informed consent.

Exclusion Criteria
Patients were excluded if they fulfilled any of the following criteria:
Presence of contraindications to MRI, including:

- oCardiac pacemaker
- oIntracranial aneurysm clips
- oCochlear implants
- oOther MRI-incompatible metallic implants
- Pregnancy during the first trimester.
- Patients with severe claustrophobia who underwent an alternative imaging modality.
- Patients referred for pelvic MRI for non-gynecological indications.
- Patients unwilling to participate in the study.

Patient Preparation
Before MRI examination, all patients underwent detailed clinical evaluation including:

- Presenting complaints
- Menstrual history
- Obstetric history
- Previous pelvic surgery
- History of pelvic inflammatory disease
- Previous malignancy
- Presence of intrauterine contraceptive devices or pelvic foreign bodies

Patients were instructed to:

- Empty the urinary bladder before examination.
- Evacuate bowel contents whenever possible.
- Remove all metallic objects before entering the MRI suite.

MRI contraindications were reassessed before imaging.

MRI Equipment
All examinations were performed using a:
1.5 Tesla Siemens Magnetic Resonance Imaging Scanner
Department of Radiodiagnosis
VMKV MCH Salem Tamilnadu

MRI Protocol
Routine pelvic MRI protocol included the following sequences:

Sequence	Purpose

Axial T1-weighted imaging	Anatomical assessment, hemorrhage, fat detection
Axial, sagittal and coronal T2-weighted imaging	Primary lesion characterization
Diffusion-weighted imaging (DWI)	Assessment of diffusion restriction
Apparent Diffusion Coefficient (ADC) mapping	Tissue characterization
Susceptibility-weighted imaging (SWI)	Hemorrhage and calcification assessment
Post-contrast T1-weighted imaging	Evaluation of enhancement characteristics
Post-contrast T2-weighted imaging	Additional lesion characterization when required

Contrast Administration

Intravenous gadolinium-based contrast agent (Gadolinium-DTPA) was administered whenever indicated.
Dosage used:

- 10 mL for patients older than 12 years
- 5 mL for patients younger than 12 years

Each milliliter contained 469 mg of gadolinium contrast material.
Contrast was administered intravenously as a bolus injection followed by saline flush.

Image Interpretation

MRI examinations were independently interpreted by experienced radiologists.
The following imaging characteristics were evaluated:

- Site of lesion
- Size
- Shape
- Margins
- Signal intensity on T1WI
- Signal intensity on T2WI
- Diffusion restriction
- ADC characteristics
- Contrast enhancement pattern
- Adjacent organ invasion
- Lymph node involvement
- Presence of metastasis
- Associated pelvic abnormalities

The conspicuity of lesions was compared between:

- Plain MRI
- Contrast-enhanced MRI (CEMR)

Findings were categorized as:

- CEMR better
- CEMR equivalent to plain MRI

Reference Standard

Final diagnosis was established using one or more of the following:

- Histopathological examination
- Surgical findings
- Clinical diagnosis

- Follow-up imaging
- Treatment response

Histopathological diagnosis served as the reference standard whenever tissue diagnosis was available.

Outcome Measures

The primary outcome was the diagnostic performance of MRI in detecting female genital tract pathologies.
Secondary outcome measures included:

- Distribution of gynecological diseases
- MRI characteristics of individual lesions
- Comparison of benign and malignant lesions
- Utility of contrast-enhanced MRI
- Correlation between MRI and histopathological diagnosis

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software (Version 15).
Continuous variables were summarized using descriptive statistics.
Categorical variables were expressed as frequencies and percentages.
Results were presented in the form of tables and graphs.
MRI diagnoses were compared with final diagnoses obtained from histopathological examination or clinical follow-up.

Results

A total of 100 female patients with clinically suspected gynecological disorders underwent pelvic MRI during the study period. MRI findings were subsequently compared with the final diagnosis established by histopathological examination whenever available or by clinical diagnosis and treatment response in the remaining cases.
The demographic profile, spectrum of diseases, clinical presentation, and imaging findings are summarized below.

Age Distribution

The age of patients ranged from childhood to more than 60 years. The majority of patients belonged to the 31–40 years age group (30%), followed by the 41–50 years age group (24%).

Table 1. Age Distribution of Study Population

Age Group (Years)	Number of Patients (n)	Percentage (%)
0–30	21	21
31–40	30	30
41–50	24	24
51–60	12	12
>60	13	13
Total	100	100

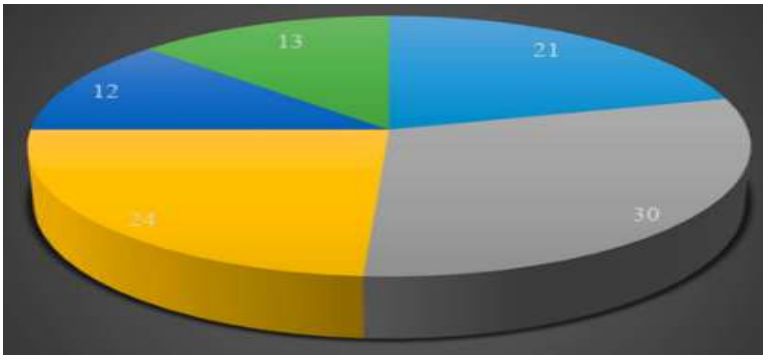


Figure 1. Age distribution of study participants.

Interpretation

The highest proportion of patients was observed in the 31–40 years age group (30%), followed by the 41–50 years group (24%). Together, these two age groups constituted more than half of the study population.

Spectrum of Female Genital Tract Pathologies

MRI demonstrated a wide spectrum of gynecological disorders. Cervical carcinoma was the most frequently diagnosed pathology.

Table 2. Distribution of Female Genital Tract Pathologies

Pathology	Cases (n)	Percentage (%)
Cervical carcinoma	16	16
Ovarian carcinoma	11	11
Endometrial carcinoma	13	13
Ovarian cystic lesions	10	10
Fibroids	12	12
Adenomyosis	7	7
Endometriosis	5	5
Uterine polyps	4	4
Congenital anomalies	7	7
Other gynecological lesions	7	7
Normal MRI findings	11	11
Total	100	100

Interpretation

Among all pathological conditions, cervical carcinoma (16%) was the most common diagnosis, followed by endometrial carcinoma (13%), uterine fibroids (12%), ovarian carcinoma (11%), and ovarian cystic lesions (10%). Normal MRI findings were observed in 11% of patients.

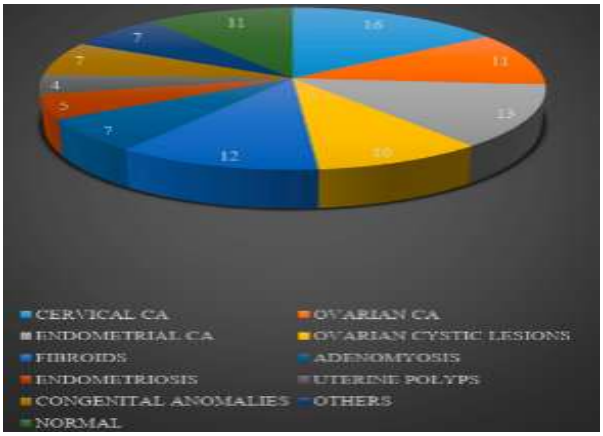


Figure 2. Distribution of female genital tract pathologies

Clinical Presentation

Lower abdominal pain was the commonest presenting symptom among the study participants.

Table 3. Clinical Presentation of Patients

Clinical Finding	Cases (n)	Percentage (%)
Lower abdominal pain	78	44.3
Abnormal uterine bleeding	50	28.4
Anorexia	39	22.1
Weight loss	39	22.1
Vaginal discharge	17	9.6
Pregnancy failure	31	17.6

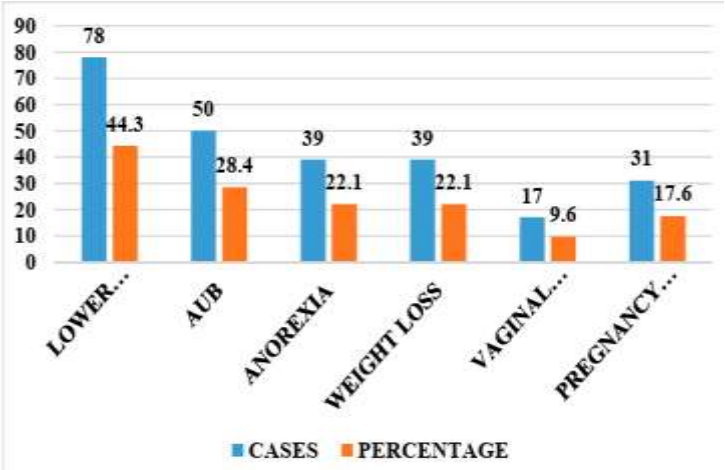


Figure 3. Clinical presentation among study participants.

Interpretation

Lower abdominal pain was the predominant presenting complaint (44.3%), followed by abnormal uterine bleeding (28.4%). Constitutional symptoms such as anorexia and weight loss were each present in 22.1% of patients, while pregnancy failure was documented in 17.6%.

Distribution of Fibroid Types

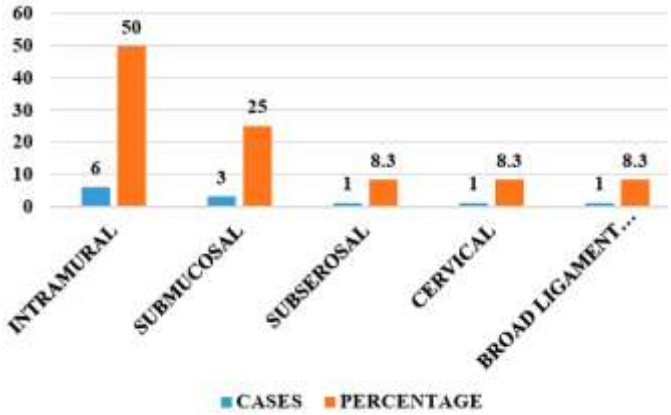
Among the twelve patients diagnosed with uterine fibroids, intramural fibroids constituted the largest subgroup.

Table 4. Types of Uterine Fibroids

Fibroid Type	Cases (n)	Percentage (%)
Intramural	6	50.0
Submucosal	3	25.0
Subserosal	1	8.3
Cervical	1	8.3
Broad ligament fibroid	1	8.3
Total	12	100

Figure 4. Distribution of fibroid types.

Interpretation



Intramural fibroids represented 50% of all fibroids detected, followed by submucosal fibroids (25%). Subserosal, cervical, and broad ligament fibroids each accounted for 8.3%.

Benign versus Malignant Ovarian Lesions

A total of 32 ovarian lesions were identified.

Table 5. Distribution of Ovarian Lesions

Ovarian Lesion	Cases (n)	Percentage (%)
Benign ovarian lesions	24	75
Malignant ovarian lesions	8	25
Total	32	100

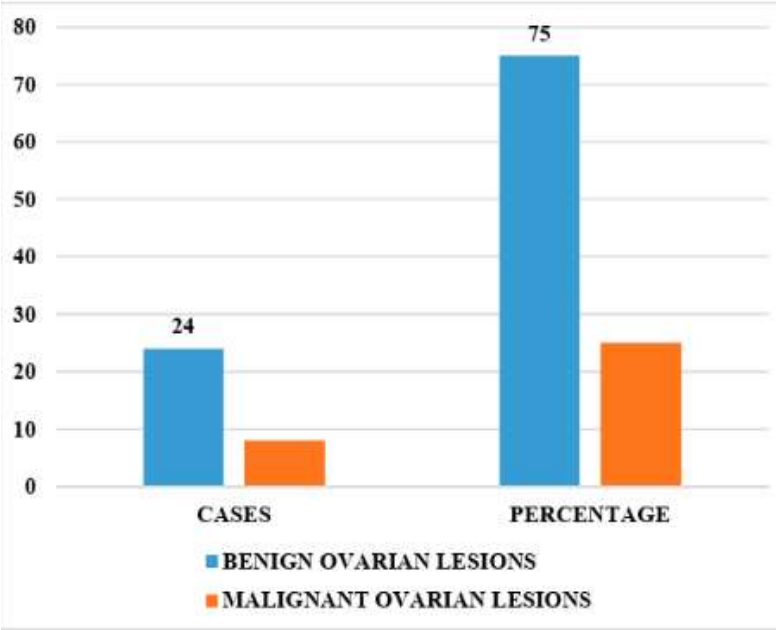


Figure 5. Benign versus malignant ovarian lesions.

Interpretation

Benign ovarian lesions predominated, accounting for 75% of ovarian lesions, whereas malignant ovarian lesions constituted 25%.

Distribution of Female Genital Tract Malignancies

Forty patients were diagnosed with malignant neoplasms of the female genital tract.

Table 6. Distribution of Gynecological Malignancies

Malignancy	Cases (n)	Percentage (%)
Cervical carcinoma	16	40.0
Ovarian carcinoma	11	27.5
Endometrial carcinoma	13	32.5
Total	40	100

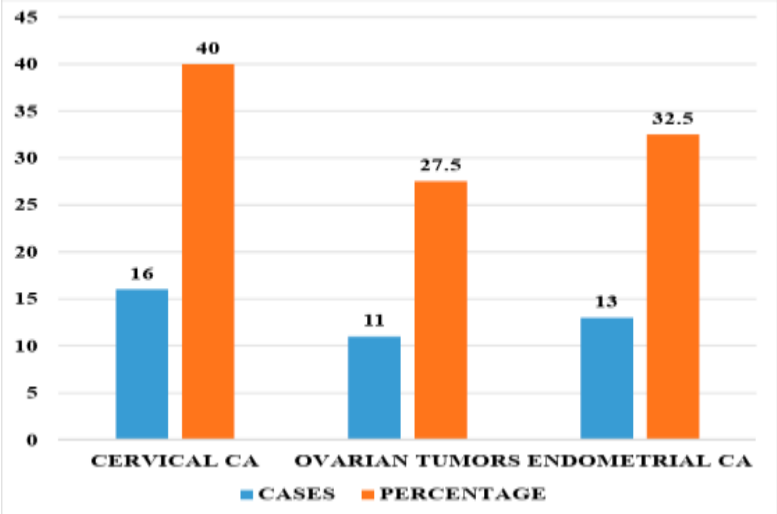


Figure 6. Distribution of malignant female genital tract lesions.

Interpretation

Cervical carcinoma represented the largest proportion (40%) of gynecological malignancies, followed by endometrial carcinoma (32.5%) and ovarian carcinoma (27.5%).

Contrast Enhancement in Neoplastic Lesions

The conspicuity of malignant lesions on contrast-enhanced MRI (CEMR) was compared with that of plain MRI to determine whether contrast administration improved lesion detection and characterization.

Table 7. Conspicuity of Neoplastic Female Genital Tract Pathologies on Contrast-Enhanced MRI

Neoplastic Pathology	CEMR Better (n)	CEMR Equivalent to Plain MRI (n)
Cervical carcinoma	4	12
Endometrial carcinoma	11	2
Ovarian tumors	9	2
Total	24	16

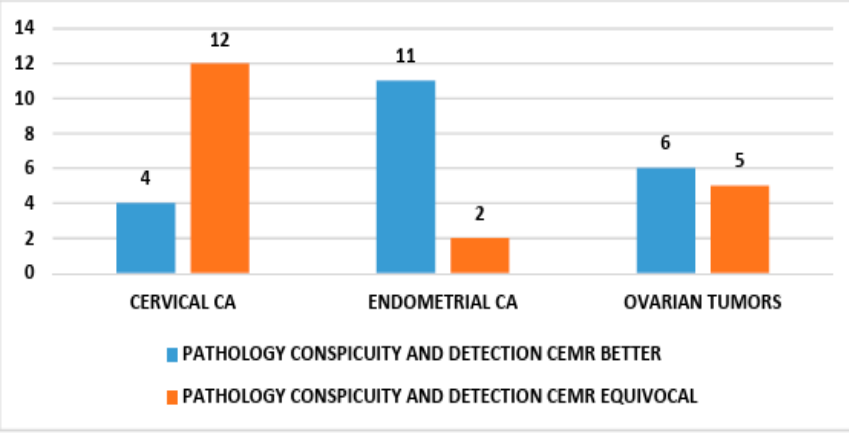


Figure 7. Comparison of lesion conspicuity on contrast-enhanced MRI and plain MRI in neoplastic female genital tract lesions.

Interpretation

Among the 40 neoplastic lesions, 24 (60%) demonstrated improved lesion conspicuity following contrast administration, whereas 16 (40%) showed no significant additional benefit over plain MRI.

Contrast-enhanced MRI was particularly useful in endometrial carcinoma (11 of 13 cases) and ovarian tumors (9 of 11 cases). In contrast, most cases of cervical carcinoma (12 of 16 cases) were adequately characterized on non-contrast MRI, indicating that routine MRI sequences are often sufficient for diagnosis and local assessment of cervical cancer.

Contrast Enhancement in Benign Lesions

The value of contrast-enhanced MRI was also assessed in benign gynecological pathologies.

Table 8. Conspicuity of Benign Female Genital Tract Pathologies on Contrast-Enhanced MRI

Benign Pathology	CEMR Better (n)	CEMR Equivalent to Plain MRI (n)
Ovarian cystic lesions	1	9
Fibroids	9	3
Adenomyosis	0	7
Tubo-ovarian abscess	3	0
Endometriosis	0	5
Endometrial polyps	0	4
Congenital anomalies	0	7
Total	13	35

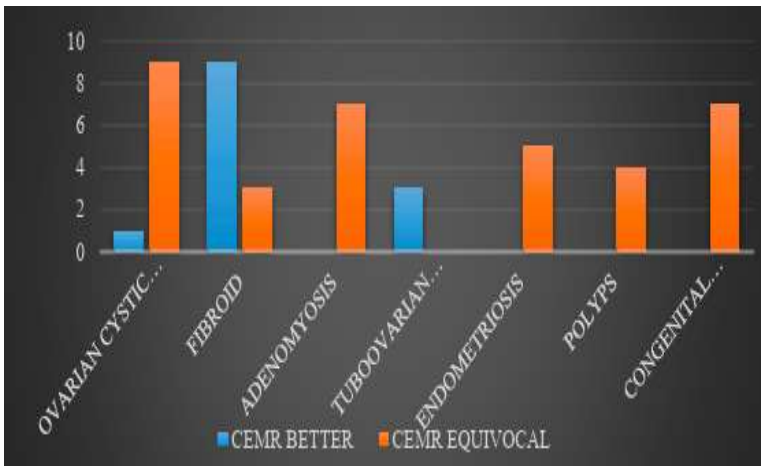


Figure 8. Comparison of lesion conspicuity on contrast-enhanced MRI and plain MRI in benign female genital tract lesions.

Interpretation

Among the 48 benign lesions, only 13 (27.09%) demonstrated improved visualization following contrast administration, whereas 35 (72.91%) showed comparable diagnostic performance on plain MRI.

Contrast enhancement was most beneficial in:

- Uterine fibroids
- Tubo-ovarian abscesses

Conversely, adenomyosis, endometriosis, congenital uterine anomalies, endometrial polyps, and most ovarian cystic lesions were accurately diagnosed using routine MRI sequences without requiring intravenous contrast.

Overall Results Summary

The present study included 100 women who underwent pelvic MRI for suspected gynecological disease.
The principal findings were:

- The highest proportion of patients belonged to the 31–40-year age group.
- Cervical carcinoma was the most common malignant lesion.
- Lower abdominal pain was the most frequent presenting complaint.
- Intramural fibroids constituted half of all uterine fibroids.
- Most ovarian lesions were benign.
- Contrast-enhanced MRI significantly improved characterization of malignant lesions, particularly endometrial carcinoma and ovarian tumors.
- Routine MRI sequences alone were adequate for diagnosing the majority of benign pelvic disorders and many cases of cervical carcinoma.

Discussion

Magnetic Resonance Imaging (MRI) has become the imaging modality of choice for comprehensive evaluation of female genital tract disorders because of its excellent soft-tissue contrast, multiplanar imaging capability, and superior tissue characterization. The present prospective cross-sectional study assessed the role of MRI in evaluating various female genital tract pathologies and correlated imaging findings with histopathological diagnosis or clinical follow-up. The findings demonstrate that MRI accurately characterizes benign and malignant lesions, assists in preoperative planning, and provides valuable information for patient management.

Age Distribution

In the present study, the highest proportion of patients belonged to the 31–40-year age group (30%), followed by the 41–50-year age group (24%). This predominance reflects the higher incidence of gynecological disorders during the reproductive and perimenopausal periods, when hormonal influences, reproductive factors, and neoplastic conditions are more prevalent.
Similar age distributions have been reported in previous MRI-based studies of female pelvic pathology, where women in the third and fourth decades constituted the largest patient population. This finding emphasizes the importance of MRI in evaluating symptomatic women during their reproductive years.

Spectrum of Female Genital Tract Pathologies

Cervical carcinoma was the most common pathology encountered in this study, accounting for 16% of all cases, followed by endometrial carcinoma (13%), uterine fibroids (12%), ovarian carcinoma (11%), and ovarian cystic lesions (10%).
The predominance of cervical carcinoma is consistent with the disease burden in India, where it remains one of the leading gynecological malignancies despite advances in screening and vaccination. MRI played a crucial role in determining tumor size, stromal invasion, parametrial extension, pelvic sidewall involvement, lymph node enlargement, and adjacent organ invasion, all of which are essential for accurate staging and treatment planning.
Similarly, MRI accurately characterized endometrial carcinoma by demonstrating endometrial thickening, depth of

myometrial invasion, cervical stromal involvement, and extrauterine extension. These imaging features are critical in determining surgical management and prognosis.

Clinical Presentation

Lower abdominal pain was the most common presenting complaint, followed by abnormal uterine bleeding. Constitutional symptoms such as anorexia and weight loss were predominantly observed among patients with malignant lesions.

These findings correlate well with the established clinical manifestations of gynecological disorders. Although these symptoms are nonspecific, MRI effectively localized the underlying pathology and differentiated benign from malignant causes.

Uterine Fibroids

Among patients diagnosed with leiomyomas, intramural fibroids constituted 50% of cases, making them the most common subtype. MRI accurately identified the location, number, size, and degeneration of fibroids while differentiating them from adenomyosis and other uterine masses.

Because of its excellent soft-tissue contrast, MRI is superior to ultrasonography for mapping multiple fibroids before surgery and is particularly valuable in women being considered for myomectomy or uterine artery embolization.

Ovarian Lesions

The majority (75%) of ovarian lesions were benign, whereas 25% were malignant.

MRI effectively differentiated benign from malignant ovarian masses by evaluating lesion morphology, wall thickness, septations, papillary projections, solid components, hemorrhage, fat, diffusion restriction, and enhancement characteristics.

These findings highlight the important role of MRI in reducing unnecessary surgery for benign lesions while ensuring timely referral for oncological management in malignant cases.

Role of Contrast-Enhanced MRI

Contrast-enhanced MRI significantly improved lesion characterization in malignant tumors, particularly endometrial carcinoma and ovarian malignancies. Enhancement patterns facilitated more accurate assessment of tumor extent, necrosis, myometrial invasion, and adjacent organ involvement.

However, the study also demonstrated that routine MRI sequences alone were sufficient for evaluating many benign conditions, including adenomyosis, congenital uterine anomalies, endometriosis, and uncomplicated ovarian cysts. Therefore, intravenous contrast should be used selectively when additional tissue characterization or staging information is required.

Histopathological Correlation

MRI findings showed excellent agreement with histopathological diagnosis whenever tissue diagnosis was available. The modality accurately characterized lesion morphology, anatomical extent, and tissue composition, thereby increasing diagnostic confidence and assisting clinicians in selecting appropriate treatment strategies.

This strong radiologic-pathologic correlation supports the role of MRI as the reference imaging modality for complex female genital tract disorders.

Clinical Significance

The findings of the present study reinforce the importance of MRI in routine gynecological practice. MRI provides comprehensive evaluation of congenital anomalies, benign uterine disorders, ovarian lesions, inflammatory conditions, and gynecological malignancies within a single examination.

Accurate lesion characterization reduces diagnostic uncertainty, improves surgical planning, minimizes unnecessary invasive procedures, and facilitates multidisciplinary decision-making. In oncological patients, MRI contributes significantly to staging, treatment planning, and follow-up assessment.

Conclusion

Magnetic Resonance Imaging (MRI) is a highly effective and comprehensive imaging modality for the evaluation of female genital tract pathologies owing to its superior soft-tissue contrast, multiplanar imaging capability, and excellent tissue characterization. In the present study, MRI accurately identified and characterized a broad spectrum of congenital, benign, inflammatory, and malignant gynecological lesions, demonstrating its pivotal role in the diagnostic work-up of women presenting with pelvic symptoms.

The study showed that cervical carcinoma was the most common malignant pathology, followed by endometrial carcinoma and ovarian carcinoma, while uterine fibroids represented the most frequent benign uterine lesion. MRI effectively differentiated benign from malignant lesions, accurately determined lesion extent, assessed local invasion, and provided essential preoperative staging information. Contrast-enhanced MRI significantly improved lesion characterization in malignant neoplasms, particularly endometrial and ovarian malignancies, whereas routine MRI sequences were adequate for diagnosing most benign conditions, including adenomyosis, endometriosis, congenital uterine anomalies, and uncomplicated ovarian cystic lesions.

Correlation of MRI findings with histopathological diagnosis and clinical follow-up demonstrated excellent diagnostic reliability, reinforcing MRI as the reference imaging modality for comprehensive pelvic evaluation. Accurate lesion characterization facilitated appropriate clinical decision-making, optimized treatment planning, and reduced diagnostic uncertainty.

In conclusion, MRI should be considered the imaging modality of choice for the evaluation of complex female genital tract disorders, especially when ultrasonography is inconclusive or when detailed anatomical assessment and preoperative staging are required. Its ability to provide precise anatomical localization, superior lesion characterization, and accurate disease staging makes MRI an indispensable tool in modern gynecological imaging, ultimately contributing to improved patient management and clinical outcomes.

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