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Role of MRI in Evaluating Gynecological Pathology

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ABSTRACT
Uterine and adnexal masses pose a diagnostic challenge due to their varied nature, ranging from benign to malignant. MRI has emerged as a valuable imaging modality for the evaluation of these masses, providing detailed information on their internal characteristics, enhancement patterns and origin. This study aimed to evaluate the role of MRI in the diagnosis and characterization of uterine and adnexal masses in female patients, with an emphasis on differentiating between benign and malignant lesions. This cross-sectional descriptive study involved 73 consecutive female patients clinically suspected of having uterine or adnexal masses, who were referred to the Department of Radiodiagnosis at G.S.L Medical College and General Hospital for MRI imaging from January 1, 2015, to June 31, 2016. MRI findings were analyzed for lesion origin, internal characteristics, enhancement patterns and the presence of fat planes. Statistical analysis was conducted using SPSS version 2.0 and Microsoft Excel 2007. The majority of lesions (61.7%) were of uterine origin, with ovarian lesions accounting for 20.5% and adnexal lesions for 5.5%. Uterine fibroids (19.3%) and ovarian cysts/masses (16.5%) were the most common findings. Gadolinium enhancement was present in 41% of uterine lesions and 59% of adnexal/ovarian lesions. Fat planes were preserved in 79.5% of lesions. Benign lesions were more frequent than malignant ones, with benign adnexal masses making up 44.5% of cases compared to 29.6% for malignant lesions. MRI is an effective imaging modality for evaluating uterine and adnexal masses, offering detailed visualization that aids in differentiating between benign and malignant lesions. Gadolinium enhancement and preserved fat planes were key features in the characterization of these masses. The result of this study shows the importance of MRI in guiding clinical decision-making and reducing unnecessary surgical interventions.

INTRODUCTION

Adnexal masses present a significant diagnostic challenge, largely due to the fact that benign masses are far more common than malignant ones. Accurate differentiation between benign and malignant lesions is essential for proper management and is heavily dependent on imaging techniques[1]. Advanced modalities such as ultrasonography (US), computed tomography (CT) and magnetic resonance imaging (MRI) play a pivotal role in the diagnosis and management of pelvic pathologies[2]. Ultrasound is typically the first-line imaging modality for evaluating adnexal masses. While Ultrasound is highly accurate in identifying benign lesions, its sensitivity for detecting malignancy is limited[3]. In cases where Ultrasound findings are inconclusive, CT and MRI are often employed. MRI, in particular, has been shown to be superior due to its excellent soft tissue contrast and multi planar capabilities, which allow for precise localization and characterization of pelvic masses[4]. The incorporation of fast spin-echo sequences and advanced phased array coils in MRI technology has enabled the acquisition of high-resolution images in shorter scan times, significantly improving the diagnostic accuracy for adnexal masses and facilitating more specific diagnoses[5]. Over the past decade, MRI has gained increasing importance in the evaluation of uterine and ovarian lesions. This is due to several factors: advancements in MRI hardware and software that allow for high-resolution imaging, the rise of minimally invasive gynecologic treatments requiring more accurate preoperative assessments, and studies demonstrating that MRI can reduce costs by preventing unnecessary surgeries through more precise diagnoses[6]. Although MRI involves exposure to static and oscillating magnetic fields, current evidence suggests that these levels do not pose any long-term biological risks. Studies on workers exposed to magnetic fields up to 2T have reported no adverse health effects. However, the RF fields used in MRI have the potential to generate tissue heating. To address this, the FDA has set guidelines for the safe operation of MRI systems, ensuring that equipment complies with these safety standards prior to clinical use[7]. MRI is particularly well-suited for gynecologic imaging due to its non-invasive nature, high tissue contrast and ability to provide multi planar views. It excels in determining the origin of masses and differentiating between various lesion types[8]. While both MRI and ultrasound have high sensitivity for detecting malignant adnexal masses (97% and 100%, respectively), MRI has a notably higher specificity (84%) and overall accuracy (89%) compared to Doppler ultrasound (40% specificity, 64% accuracy). This increased specificity allows MRI to more accurately identify benign lesions that may otherwise appear suspicious on ultrasound, thereby preventing unnecessary radical surgeries[9]. The objectives of this study are to differentiate between neoplastic and non-neoplastic utero-ovarian lesions, determine the origin, tissue composition and characteristics of monographically inconclusive uterine and adnexal masses and assist in staging known malignant conditions. These aims are intended to enhance diagnostic precision and optimize patient management strategies.

MATERIALS AND METHODS

The study involved 73 consecutive female patients suspected of having uterine or adnexal masses. These patients were referred to the Department of Radiodiagnosis at G.S.L Medical College and General Hospital for MRI imaging from January 1, 2015, to June 31, 2016.

Inclusion Criteria: The study included female patients with pelvic lesions referred for MRI evaluation by the Department of Radiodiagnosis.

Exclusion Criteria: Patients were excluded from the study under the following conditions:

- Major traumatic injuries, such as liver or splenic rupture and flail chest.
- Unstable vital signs, particularly in trauma cases.
- Claustrophobia, preventing MRI examination.

Contraindications for MRI Examination: Patients with the following conditions were contraindicated for MRI:

- Presence of cardiac pacemakers.
- Cochlear implants.
- Tissue expanders.
- Ocular prostheses.
- Dental implants.
- Neurostimulators.
- Bone growth stimulators.

MRI Equipment and Imaging Protocol: The MRI examinations were performed using a Philips Achieva A Series MRI machine with a 1.5 Tesla active-shielded superconducting magnet. SENSE coils were utilized for high-resolution image acquisition.

Ethical Considerations: The study adhered to strict ethical guidelines:

- Ethical approval was obtained from the Institutional Ethics Committee (IEC).
- Written informed consent was obtained from all participants.
- No undue pressure was applied to participants to join the study.
- Data confidentiality was maintained by securely storing all research materials.

MRI Imaging Technique and Evaluation: MRI evaluation of the lesions included a comprehensive analysis of the lesion's origin, size, shape, enhancement pattern (homogeneous or heterogeneous), as well as the presence of fatty or hemorrhagic components. Other relevant findings were also noted. The following imaging sequences were used for the evaluation:

- Sagittal T2-weighted fast spin-echo.
- Axial T2-weighted fast spin-echo.
- Coronal T2-weighted fast spin-echo.
- Axial T1-weighted fast spin-echo.
- Sagittal T2-weighted fat saturation.

These MRI sequences provided detailed visualization of the adnexal and uterine masses, aiding in accurate diagnosis and characterization.

Statistical Analysis: The statistical analysis was conducted using SPSS version 20.0 and Microsoft Excel 2007. Data were described using mean±standard deviation and presented as percentages where appropriate.

RESULTS AND DISCUSSIONS

Table 1: Age Distribution of Patients

Age in years	No. of patients	Percentage
11-20	5	6.8
21-30	11	15.1
31-40	16	22
41-50	20	27.4
51-60	12	16.4
61-70	5	6.8
71-80	4	5.5
Total	73	100

The (Table 1) presents the age distribution of 73 patients with uterine and adnexal masses. The majority of the patients fall within the 41-50 age group (27.4%), followed by the 31-40 age group (22%) and the 51-60 age group (16.4%). Patients in the younger age groups (11-20 and 21-30) accounted for 6.8% and 15.1% of cases, respectively. The older age groups (61-70 and 71-80) represented 6.8% and 5.5% of the total patient population. This distribution highlights that most cases were observed in middle-aged women, particularly between 31 and 60 years.

Table 2 : Clinical Diagnosis of Patients Studied

Clinical presentation	No. of patients	Percentage
Mass per abdomen	21	29.0
Menorrhagia	8	11
Dysmenorrhoea	1	1.3
Bleeding P/V	7	9.6
Primary Amenorrhoea	1	1.3
Infertility	5	6.8
Irregular cycles	3	4.2
Pelvic pain	8	11
Post menopausal bleeding (PMB)	6	8.2
White discharge P/V	10	13.6
Post coital bleeding	1	1.3
Retention of urine	2	2.7
Total	73	100

The (Table 2) outlines the clinical symptoms observed in 73 patients with uterine and adnexal masses. The most common presentation was a mass per abdomen, seen in 29% of cases. Other frequent symptoms included white discharge per vagina (13.6%), menorrhagia (11%), pelvic pain (11%) and postmenopausal bleeding (8.2%). Less common symptoms included bleeding per vagina (9.6%), infertility (6.8%), irregular menstrual cycles (4.2%) and retention of urine (2.7%). Rare presentations such as dysmenorrhea, primary amenorrhea, postcoital bleeding and urinary retention each accounted for 1.3% of cases. This distribution reflects a wide range of gynecological symptoms associated with uterine and adnexal masses.

Table 3: MRI Findings of Patients Studied

MRI	No. of patients	Percentage
Uterine Fibroid	14	19.3
Adenomyosis	4	5.5
Uterine didelphys	2	2.7
Bicornuate uterus	1	1.3
Absent uterus and cervix	1	1.3
Unicornuate uterus	1	1.3
Endometrial Carcinoma	6	8.4
Thickened endometrium ? Malignant	3	4.2
Endometrial polypoidal mass ?Malignancy	1	1.3
Carcinoma Cervix	12	16.5
Hematometrocolpus	1	1.3
Hydrosalpinx	2	2.7
Complex adnexal TO masses	2	2.7
Adnexal cysts/masses *	8	11
Ovarian cysts/masses	12	16.5
Ovarian Dermoid	2	2.7
Hemorrhagic ovarian cyst	1	1.3
Total	73	100

The (Table 3) summarizes the MRI findings of 73 patients with uterine and adnexal masses. Uterine fibroids were the most common diagnosis, seen in 19.3% of cases. Other notable conditions included ovarian cysts or masses (16.5%), carcinoma of the cervix (16.5%) and adnexal cysts/masses (11%). Endometrial carcinoma was observed in 8.4% of patients, while 4.2% had a thickened endometrium suspected to be malignant. Less common findings included autonomists (5.5%), uterine anomalies such as uterine didelphys (2.7%), hydrosalpinx (2.7%) and complex adnexal tubo-ovarian masses (2.7%). Other rare conditions like endometrial polypoidal masses with suspected malignancy, ovarian dermoid and hemorrhagic ovarian cysts each accounted for 1.3% of cases. This distribution highlights the diversity of uterine and adnexal pathologies detected by MRI.

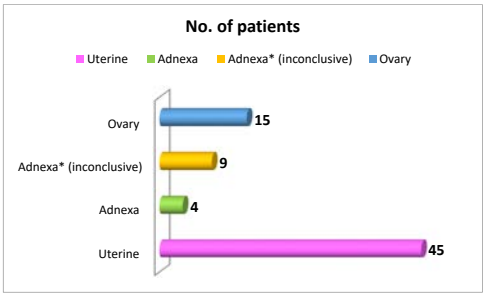

Fig. 1: Distribution of Lesions by Location

The (fig. 1) shows the distribution of lesions among 73 patients based on their location. The majority of lesions were uterine in origin, accounting for 61.7% of cases. Ovarian lesions made up 20.5%, while adnexal lesions were identified in 5.5% of patients. Additionally, 12.3% of adnexal lesions were classified as inconclusive. This data highlights that most pelvic masses were of uterine origin, with a smaller but significant portion originating in the ovaries and adnexa.

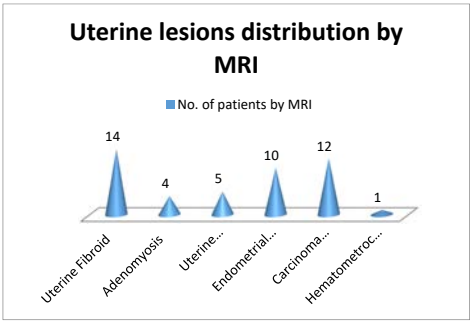

Fig. 2: Distribution of Uterine Lesions by MRI Findings

The (Fig. 2) provides an overview of uterine lesions detected by MRI in 45 patients. Uterine fibroids were the most common lesion, accounting for 30.4% of cases, followed closely by carcinoma of the cervix at 26%. Endometrial malignancies were found in 21.8% of patients. Uterine anomalies, such as didelphys or bicornuate uterus, made up 10.9% of cases, while adenomyosis was observed in 8.7%. A rare case of hematometrocolpus was noted, representing 2.2% of the total. These findings highlight the predominance of fibroids and malignancies in uterine pathology.

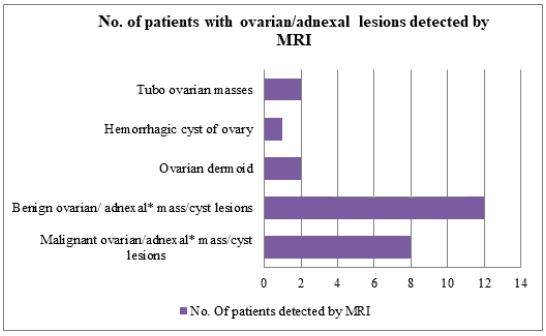

Fig. 3: Distribution of Adnexal/Ovarian Lesions by MRI Findings

The (Fig. 3) summarizes the MRI findings of adnexal and ovarian lesions in 27 patients. Benign ovarian/adnexal masses or cysts were the most frequently detected, accounting for 44.5% of cases. Malignant ovarian or adnexal masses/cysts were observed in 29.6% of patients. Other notable findings included ovarian dermoid (7.4%), tubo-ovarian masses (7.4%), hydrosalpinx (7.4%) and hemorrhagic cyst of the ovary (3.7%).

Table 4: Ovarian Lesions Distribution by Final Diagnosis

Ovarian lesions by final diagnosis	No. of patients	Percentage
Serous cystadenoma of ovary	7	29.1
Mucinous cystadenoma of ovary	5	20.8
Cystadenocarcinoma of ovary	6	25
Poorly differentiated ovarian carcinoma	1	4.2
Ovarian dermoid	2	8.3
Ovarian fibroma	1	4.2
Dysgerminoma	1	4.2
Hemorrhagic ovarian cyst	1	4.2
Total	24	100

The (Table 4) presents the final diagnosis of ovarian lesions in 24 patients. The most common lesion was serous cystadenoma, accounting for 29.1% of cases, followed by mucinous cystadenoma (20.8%) and cystadenocarcinoma (25%). Less frequent diagnoses included ovarian dermoid (8.3%), poorly differentiated ovarian carcinoma (4.2%), ovarian fibroma (4.2%), dysgerminoma (4.2%) and hemorrhagic ovarian cyst (4.2%). The (Table 5) outlines the internal characteristics of uterine and adnexal/ovarian lesions based on MRI findings. Of the uterine lesions, 28 were solid in nature, while 2 showed both solid and cystic components and 1 was hemorrhagic. No uterine lesions were purely cystic or contained fat. A total of 14 uterine lesions had no available internal characteristic data (NA). For adnexal/ovarian lesions, 2 were solid, 9 were cystic, 11 had both solid and cystic components and 1 had a combination of solid, cystic and hemorrhagic features. Additionally, 2 adnexal/ ovarian lesions contained fat, and 1 was hemorrhagic. Two adnexal/ovarian lesions had no available internal characteristic data (NA). In total, the most common internal feature was solid (30 lesions), followed by both solid and cystic characteristics (13 lesions) and cystic (9 lesions). Fewer lesions were characterized as containing hemorrhage (2), fat (2), or a combination of solid, cystic and hemorrhagic features (1).

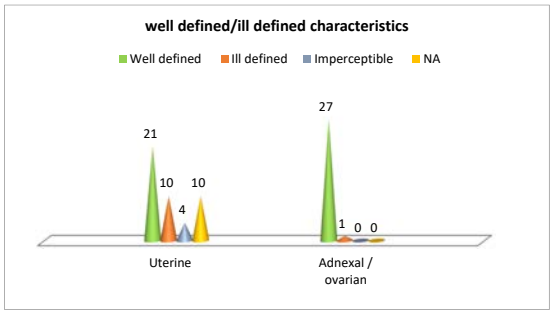

Fig. 4: Definition Characteristics of Uterine and Adnexal/Ovarian Lesions

The (fig. 4) provides an analysis of the well-defined or ill-defined characteristics of uterine and adnexal/ ovarian lesions based on MRI findings. Among the uterine lesions, 21 were well-defined, 10 were ill-defined, 4 were imperceptible and 10 had no available data (NA). For adnexal/ovarian lesions, 27 were well-defined, with only 1 ill-defined lesion. No

Table 5: Internal Characteristics of Uterine and Adnexal/Ovarian Lesions

Lesions	Solid	Cystic	Both solid and cystic	Solid, cystic, hemorrhagic	Fat	Hemorrhagic	NA
Uterine	28	0	2	0	0	1	14
Adnexal /Ovarian	2	9	11	1	2	1	2
Total	30	9	13	1	2	2	16

Table 6: Gadolinium Enhancement of Uterine and Adnexal/Ovarian Lesions

Lesions	Enhancement present	Enhancement absent	Not done
Uterine	9 (41%)	0	36
Adnexal /ovarian	13 (59%)	2	13
Total	22	2	49

adnexal/ovarian lesions were classified as imperceptible and none lacked available data. In total, 48 lesions were well-defined, 11 were ill-defined, 4 were imperceptible and 10 had no data available. This indicates that the majority of the lesions were well-defined on imaging. The (Table 6) presents the gadolinium enhancement characteristics of uterine and adnexal/ovarian lesions. Of the 22 lesions with gadolinium enhancement, 9 (41%) were uterine lesions and 13 (59%) were adnexal/ovarian lesions. No uterine lesions showed an absence of enhancement, while 2 adnexal/ovarian lesions did not enhance. A total of 49 lesions (36 uterine and 13 adnexal/ovarian) did not undergo gadolinium-enhanced imaging.

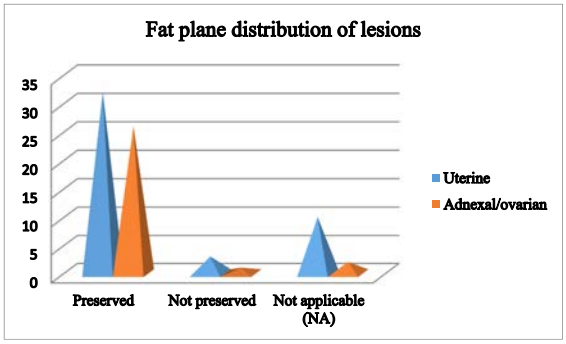

Fig. 5: Fat Planes Distribution of Uterine and Adnexal/Ovarian Lesions

The (Fig. 5) presents the fat planes distribution in uterine and adnexal/ovarian lesions. Among the uterine lesions, fat planes were preserved in 32 cases, not preserved in 3 and 10 were not applicable (NA). For adnexal/ovarian lesions, fat planes were preserved in 26 cases, not preserved in 1 and 2 were deemed not applicable. Overall, 58 lesions had preserved fat planes, while 4 lesions showed no preservation of fat planes. For 12 lesions, the assessment of fat planes was not applicable. The data suggest that the majority of both uterine and adnexal/ovarian lesions showed preserved fat planes on imaging.

The present study aimed to evaluate uterine and adnexal masses using MRI, focusing on lesion characterization, clinical presentation and imaging features. This study of 73 patients provided valuable insights into the distribution and internal characteristics of uterine and adnexal/ovarian lesions, with the majority of the cases falling within the 41-50 age group (27.4%), highlighting the prominence of these masses in middle-aged women. The findings are in agreement with previous studies that show an increased incidence of uterine and adnexal masses in this age range due to hormonal changes and reproductive aging. In our study, the most common clinical presentation was a mass per abdomen (29%), followed by white discharge per vagina (13.6%) and pelvic pain (11%). These findings align with previous studies, which also reported similar clinical presentations in patients with uterine and adnexal masses. Sousa *et al.* found that abdominal mass and pelvic pain were predominant symptoms in their cohort[10]. The presence of post-menopausal bleeding (8.2%) in some patients also supports previous findings, indicating a higher likelihood of malignancy in post-menopausal women[11]. Our study revealed that uterine fibroids (19.3%), ovarian cysts/masses (16.5%), and carcinoma of the cervix (16.5%) were the most common diagnoses. These findings are consistent with earlier studies, such as those by Sohaib *et al.,* who also reported a high prevalence of fibroids and ovarian cysts in similar age groups[12]. The high percentage of fibroids is likely due to the increased frequency of uterine fibroids in women of reproductive and perimenopausal age. Most uterine lesions were solid (62.2%), while adnexal/ovarian lesions were predominantly both solid and cystic (40.7%). This finding is in line with previous reports that emphasized the heterogeneous nature of adnexal masses, particularly in cases of complex adnexal masses like tubo-ovarian abscesses or cystadenomas[13]. The use of MRI in distinguishing solid from cystic components, particularly with gadolinium enhancement, further aided in the differentiation of benign and malignant lesions, a finding supported by previous research[14]. Gadolinium enhancement was observed in 41% of uterine lesions and 59% of adnexal/ovarian lesions in this study. This aligns with the work of Hricak *et al.,* who demonstrated that MRI with gadolinium contrast is particularly effective in identifying malignant features by enhancing solid components and differentiating between benign and malignant masses[15]. Our study's results explain the diagnostic value of gadolinium in distinguishing malignancies, particularly in adnexal masses. Fat planes were preserved in 58 lesions (79.5%), indicating a lower likelihood of invasion into adjacent structures, as seen in benign conditions. This observation concurs with

other studies that highlight the importance of preserved fat planes in benign lesions[16]. In addition, most lesions were well-defined on imaging (65.8%), which is a characteristic typically associated with benign pathology, while ill-defined lesions were more suggestive of malignancy. Compared to earlier studies, our results are consistent with the literature on the prevalence of uterine fibroids and adnexal cysts as the most common benign findings. For instance, a study by Winarto *et al.* reported similar findings in which fibroids accounted for a significant portion of uterine lesions, while ovarian cysts and masses made up a large portion of adnexal findings[17]. The malignancy rates, especially in endometrial and cervical cancer, are also comparable to global trends in gynecologic cancers. However, our study observed a slightly higher prevalence of benign adnexal masses (44.5%) compared to malignant ones (29.6%), which is consistent with other studies showing the predominance of benign pathology in pelvic masses.

CONCLUSION

This study demonstrates that MRI is a highly effective modality for the evaluation and characterization of uterine and adnexal masses, providing detailed information on lesion size, origin, internal characteristics and enhancement patterns. The majority of lesions in this study were well-defined and benign, with uterine fibroids and adnexal cysts being the most common findings. MRI, particularly with gadolinium enhancement, was crucial in distinguishing between benign and malignant lesions, which is consistent with findings from prior research. Our results also highlight the importance of MRI in detecting malignancy and guiding patient management, ultimately minimizing unnecessary surgical interventions. The study's limitations include the relatively small sample size and the single-center nature of the study. Further large-scale, multicenter studies are required to confirm these findings and enhance the diagnostic accuracy of MRI in the evaluation of pelvic masses.

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