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Diagnostic Performance of Magnetic Resonance Imaging in Female Gynecological Pelvic Masses

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Abstract

Background: Magnetic resonance imaging (MRI) is an excellent noninvasive technique to evaluate and characterize the gynecological pelvic masses, due to its high spatial resolution, excellent tissue contrast, and multiplanar imaging capability. MRI is often used to supplement ultrasonography (USG).

Aim of Study: To evaluate the accuracy of MR imaging in the detection and characterization of gynecological mass lesions and to study the spectrum of diverse nature of pelvic mass lesions, to determine the origin, tissue content and characterization of pelvic masses.

Patients and Methods: This study was conducted on 30 adult female patients with clinically or ultrasonographically suspected pelvic gynecological mass, they were subjected to pelvic Ultrasound & pelvic MRI and subsequently their findings were correlated with the gold standard (histopathological findings/Imaging follow-up).

Results: MRI was significantly superior to ultrasound in diagnosing the pelvic masses and in the evaluation of the tumor extension, myometrium invasion, detection of lymph nodes, MRI showed Sensitivity (88.9%), Specificity (95.2%), Positive Predictive value (88.9%), Negative Predictive value (95.2%) and Accuracy (93.3%).

Conclusion: MRI is an excellent tool for the assessment of disorders of the female pelvic organs, a better modality for detection, characterization of various diseases, staging patients with malignant lesions where accurate diagnosis will make an impact on their surgical and medical management planning in comparison with US.

Key Words: *Pelvic MRI-Ultrasound – Histopathology – Pelvic mass.*

Introduction

MAGNETIC resonance imaging is often used in the detection and staging of pelvic masses. Many masses in the female pelvis arise from the reproductive organs most commonly from the uterus, cervix, ovaries, and fallopian tubes. It has a broad differential diagnosis, including benign and malignant neoplasms and non-neoplastic diseases **[1]**.

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Ultrasonography (USG) is considered the first line of imaging for the female pelvis. However, there are many limitations with this modality which include limited field of view, artifacts, its dependence on the skill and experience of the operator and limited assessment of parametrial spread of disease **[2]**.

MRI is non-invasive, offering good anatomic delineation. The multiplanar imaging capability of MRI, superior soft tissue contrast and large field of view offer distinct advantages over both USG and CT (computed tomography) in the assessment of gynecologic abnormalities **[3]**.

By using a systematic approach to complex gynecological pelvic masses, incorporating the patient's clinical and surgical history, and using MRI to identify the anatomic origin, shape, composition, and the enhancement pattern, a short meaningful differential diagnosis, and often a definitive diagnosis, can be made **[4]**.

Patients and Methods

Between January 2021 and January 2022, this study was conducted on 30 adult female patients, the age range (18 to 71 years), with clinically or ultrasonographically suspected pelvic gynecological mass who were referred to the Radiodiagnosis department of Ain Shams University Hospitals.

List of Abbreviations:

MRI	: Magnetic resonance imaging.
DWIs	: Diffusion weighted images.
USG	: Ultrasonography.
IP-OOP	: In phase and Out phase.
TAUS	: Transabdominal ultrasound.
ADC	: Apparent diffusion coefficient.
TVUS	: Transvaginal Ultrasound.
CE	: Contrast enhanced.
SI	: Signal intensity.
CT	: Computed tomography.
FIGO	: International Federation of Gynecology and Obstetrics.

Exclusion criteria of the study includes: Patients with cardiac pacemaker, metallic foreign body in the eye, cerebral aneurysm clips, cochlear implant, and history of claustrophobia.

Approval has been taken from Research Ethic Committee (REC) Faculty of Medicine, Ain Shams University before conducting the study and collecting the data, and after taking consent from all patients.

Full clinical history was fulfilled to all patients, Pelvic ultrasound findings were collected. All patients underwent MRI pelvic examination, Then MRI findings were compared to the gold standard in the study which is histopathological findings or imaging follow-up (for those who didn't undergo operative procedures).

MRI films were reviewed by consultant radiologists.

Patients were asked to fast for 6-8 hours prior to the exam, and to remove any metallic objects. Full explanation of the procedure was done. The scan was done in supine head first position with pelvic phased array coil.

All MR imaging examinations were conducted at the Department of Radiology of the Ain Shams University with the same 1.5-T unit (Philips Healthcare, Best, the Netherlands) with a surface phased-array coil.

MRI contrast agent Gadolinium dimeglumine (Omniscan) 10ml was administered when indicated (in case of suspected tumor and inflammation) and after assessing the kidney functions. Nearly, 1 0ml saline flush was also given after contrast administration. MRI contrast were not recommended for patients with previous allergic reaction, or severe kidney disease.

Initially a localizer scan has been performed in transverse, sagittal and coronal orientation. Followed by the following pulse sequences:

- T1 weighted images in axial and coronal planes.
- T2 weighted images in axial and coronal planes.
- Post contrast T1FS images in axial, coronal and sagittal planes.
- In phase and out of phase sequences (IP-OOP).
- Diffusion weighted images (DWIs) as required with echo planer technique after fat suppression obtained in axial plane.

Statistical analysis:

Recorded data were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant if the p-value was <0.05.

Results

Table (1): Age "years" description among study group (n=30).

Age (years)	Total (n=30)
Range	18-71
Mean±SD	41.40± 14.56
Median	42

The study was conducted on a wide age group ranging from 18 to 71 years, (mean age of 41.43 ± 14.63 years) (Table 1).

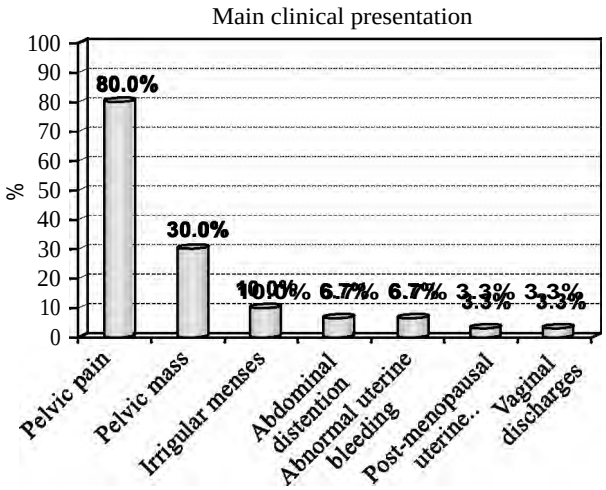


Fig. (1): Bar chart main clinical presentation distribution among study group.

The main clinical presentations among the patients were pelvic pain followed by pelvic masses (Fig. 1).

Table (2): Comparison between the origin of the lesions by US and MRI (n=30).

Origin of the lesion	US		MRI	
	No.	%	No.	%
Cervical	2	6.7	3	10.0
Indeterminate	2	6.7	0	0.0
Ovarian	14	46.7	15	50.0
Para-Ovarian	1	3.3	1	3.3
Tubo-Ovarian	2	6.7	3	10.0
Uterine	8	26.7	7	23.3
Vagina	1	3.3	1	3.3
Total	30	100.0	30	100.0
Chi-square test		2.634		
p-value		0.756		

The origin of the lesions were compared between US and MRI findings, the majority of the lesions were originated from the adnexa, then the uterus, cervix and vagina. 2 cases showed large pelvic lesions that the origin cannot be determined by US, but MRI showed that the origin was ovarian (Table 2).

Table (3): Comparison between the site of the adnexal lesions by US and MRI (n=30).

Site of Adnexal Lesion	US (n=19)		MRI (n=19)	
	No.	%	No.	%
Bilateral	5	26.3	8	42.1
Left	3	15.8	2	10.5
Right	11	57.9	9	47.4
Total	19	100.0	19	100.0
Chi-square test		1.092		
p-value		0.579		

Most of the adnexal lesions were found on the right side (9 cases), bilateral adnexal lesions were found in (8 cases), and left adnexal lesions were found in 2 cases (Table 3).

Table (4): Distribution of pelvic masses according to size on MRI (n=30).

Pelvic mass cm	Benign	Malignant	Total
<5cm	4 (13.3%)	2 (6.6%)	6 (20%)
>5cm	17 (56.6%)	7 (23.3%)	24 (80%)
Mean		23.59±22.71	

According to the size of the lesions detected by MRI, lesions measured less than 5cm (6 masses) (20%) were found to be (13.3%) benign (4 masses) and (6.6%) malignant (2 masses). And the lesions >5cm were (56.6%) benign (17 masses) and (23.3%) malignant (7 masses) (Table 4).

Table (5): Comparison between the composition of the lesions detected by US and MRI (n=30).

Composition	US		MRI	
	No.	%	No.	%
Complex	9	26.7	8	26.7
Cyst	11	43.3	12	40.0
Solid	10	33.3	10	33.3
Total	30	100.0	30	100.0
Chi-square test		0.024		
p-value		0.988		

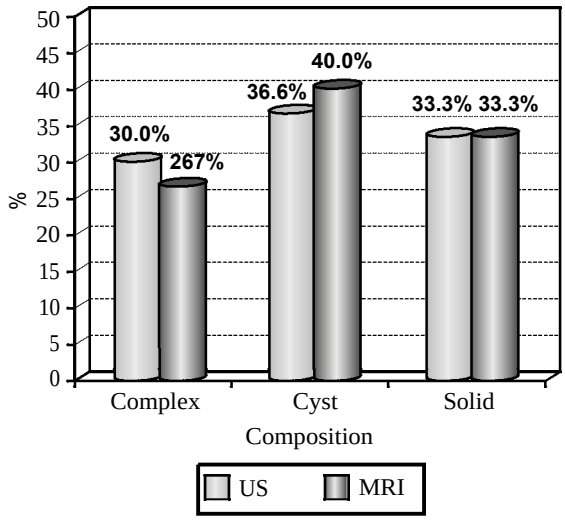


Fig. (1): Bar chart main clinical presentation distribution among study group.

Most of the lesions were cystic lesions (12 lesions), followed by solid lesions (10 lesions) then complex lesions (8 lesions). There was one complex lesion detected by ultrasound then MRI finding cleared that its composition was pure cystic lesion (Table 5) (Fig. 2).

Table (6): Diagnosis by histopathology among study group (n=19).

Diagnosis by Histopathology	No.	%
Benign	10	52.6
Malignant	9	47.3
Total	10	100.0

There were 19 patients who received surgical treatment/biopsy then followed-up for their histopathological results, there were 10 patients with benign lesions, 9 patients with Malignant lesions (Table 6).

Table (7): Imaging follow-up of the benign lesions diameters by US among study group (n=11).

Imaging follow-up of the lesion diameters by US	No.	%
Reduced in size	6	54.5
Same size	5	45.5
Total	11	100.0

The patients who received medical/non-surgical treatment (1 1 patients) have been followed by US or MRI for six months. There were 6 pelvic mass lesions that became smaller in size and 5 lesions showed the same size, with no change in the behavior of the lesions, which proved its benign nature (Table 7).

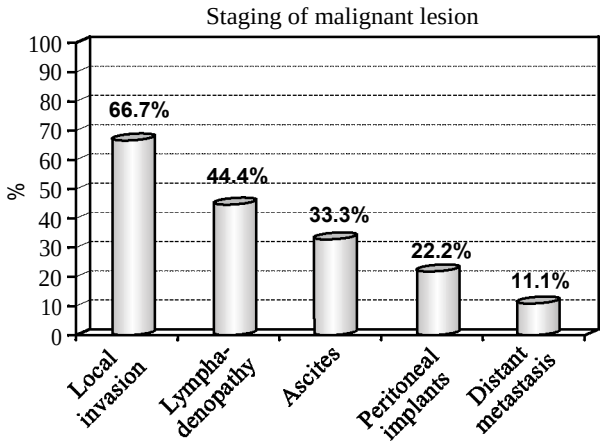


Fig. (3): Bar chart showing staging of malignant lesions among study group.

Among the staging of the malignant lesions, There were 6 patients showed local invasion, 4 patients had lymphadenopathy, 3 patients presented with malignant ascites, 2 patients had peritoneal implants and one patient showed distant metastasis (Fig. 3).

Uterine fibroids were the most common benign uterine pathologies (4 cases) (13.3%), and the most common malignant masses were endometrial carcinoma (2 cases) (6.67%) and uterine leiomyosarcoma (1 case) (3.33%) (Table 8) (Fig. 4).

The most common ovarian cancer was ovarian epithelial carcinoma (2 cases) (Table 8) (Fig. 5).

Cervical squamous cell carcinoma was the most common malignancy among the cervical lesions that were detected in the study (3 cases) (10%) (Table 8) (Fig. 5).

The most common ovarian benign lesions were Endometriotic cysts (10%)/hemorrhagic cyst (10%) followed by mature cystic teratoma (10%), ovarian mucinous cystadenoma (6.67%) and serous cystadenoma (Table 8) (Fig. 5).

Table (8): Different pathological types of the gynecological pelvic mass lesions (n=30).

Benign	No.	%	Malignant	No.	%
Gartner duct cyst	1	3.33	Uterine leiomyosarcoma	1	3.33
Tubo-ovarian abscess.	1	3.33	Endometrial adenocarcinoma	2	6.67
Hemorrhagic cysts	3	10	Ovarian epithelial carcinoma	3	10
Ovarian endometrioma	3	10	Cervical squamous cell carcinoma	3	10
Simple bilocular cyst	1	3.33			
Mature cystic teratoma	3	10			
Para-ovarian cyst	1	3.33			
Ovarian torsion	1	3.33			
Serous cystadenoma	2	3.33			
Mucinous cystadenoma	1	6.67			
Uterine Fibroids	4	10			
Total	21	70		9	30

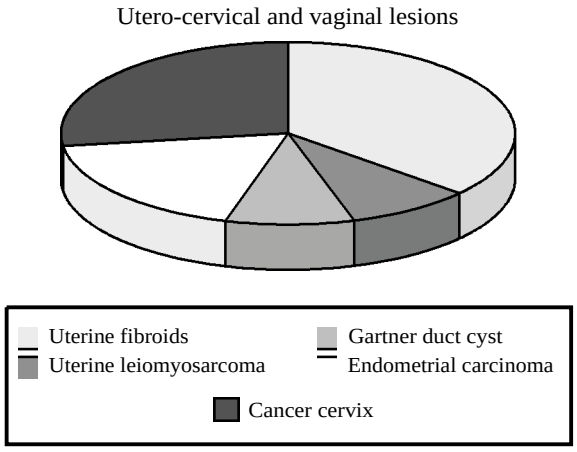


Fig. (4): Bar chart showing the frequency of Utero-cervical and vaginal lesions.

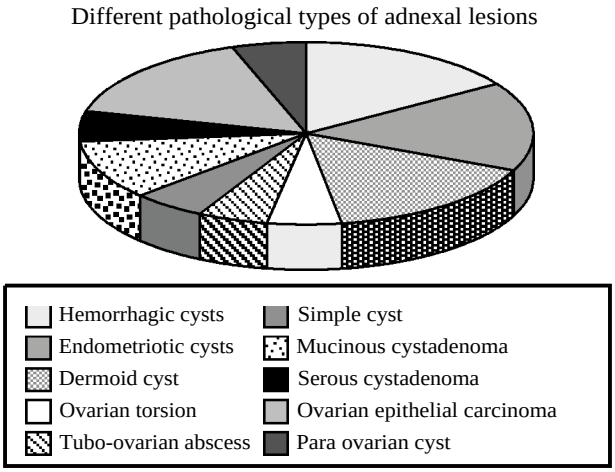


Fig. (5): Bar chart showing the frequency of different adnexal mass lesions.

As regard ultrasound in diagnosis of gynecological pelvic mass lesions it shows Sensitivity (75%), Specificity (90.9%), Positive Predictive value (75 %), Negative Predictive value (90.9%) and Accuracy (86.7%) (Table 9).

As for the diagnostic performance for the MRI in gynecological pelvic mass lesions it showed Sensitivity (88.9%), Specificity (95.2%), Positive Predictive value (88.9%), Negative Predictive value (95.2%) and Accuracy (93.3%). There was a statistical significant agreement between the two diagnosis, by comparing the gold standard and MRI a yielded weighted Kappa value of 0.789 the indicate to good agreement and p-value <0.05.

Table (9): Shows analysis of True Positive, Negative and Positive and Negative Predictive value entities with performance of diagnosis by MRI & US with diagnosis by the gold standard (histopathology /Imaging follow-up) as reference in female Gynecological pelvic masses.

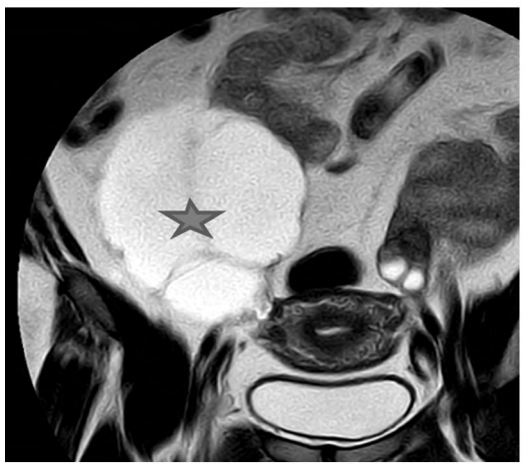
Diagnostic performance	Outcome between the Gold standard and US	Outcome between the Gold standard and MRI
TP	6	8
TN	20	20
FP	2	1
FN	2	1
Sensitivity	75%	88.9%
Specificity	90.9%	95.2%
Positive Predictive value	75%	88.9%
Negative Predictive value	90.9%	95.2%
Accuracy	86.7%	93.3%

Figs. (6,7) A 36 years old female patient with lower abdominal pain, and abdominal enlargement 3 weeks duration.

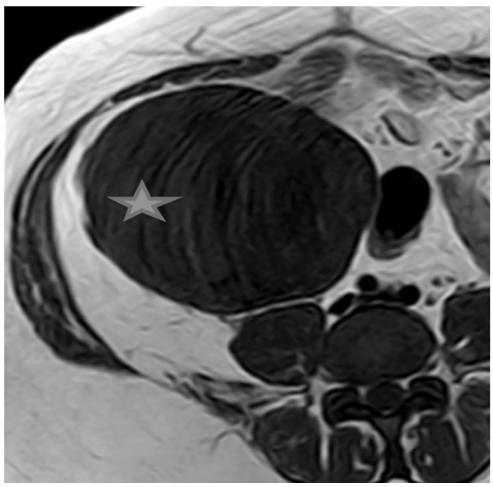
US Findings: TVUS shows right adnexal huge multi-locular thin wall cystic lesion measuring about 11x13cm, likely ovarian cystadenoma.

MRI Findings: Right adnexal region shows multi-locular large cystic lesion measuring 13x11x15cm showing high SI in T2 WIs low SI in T1 WIs with no diffusion restriction; Likely serous cystadenoma.

Fig. (6): TVUS showed right adnexa huge multi-locular thin wall cystic lesion measuring about 11x13 cm, likely ovarian cystadenoma.



(A): Coronal T2WI.



(B): Axial T1WI.

Fig. (7): MRI pelvis showed right adnexa multi-locular large cystic lesion (Asterisk) measuring 13x11x15 cm showing high SI in T2 WIs low SI in T1 WIs with no diffusion restriction; Likely serous cystadenoma.

Histopathological findings: Right ovarian Mucinous cystadenoma.

Figs. (8,9) A 65 years old female patient complaining from watery vaginal discharge and bleeding 3 months ago.

US Findings: An ill-defined hypoechoic mass lesion is seen at the cervical region with increased vascularity.

MRI Findings: Cervical soft tissue mass lesion showing heterogeneous high signal in T2 and low T1WIs with true diffusion restriction measuring about (4x3.6x1.4cm) extending to the upper third of the vagina with parametrial invasion. Likely cervical carcinoma (FIGO IIa).

Histopathological Findings: Cervical carcinoma (Squamous cell carcinoma).

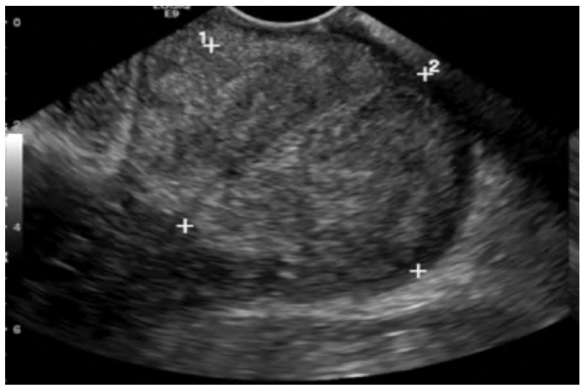


Fig. (8): TVUS showing cervical mass likely Cancer cervix.

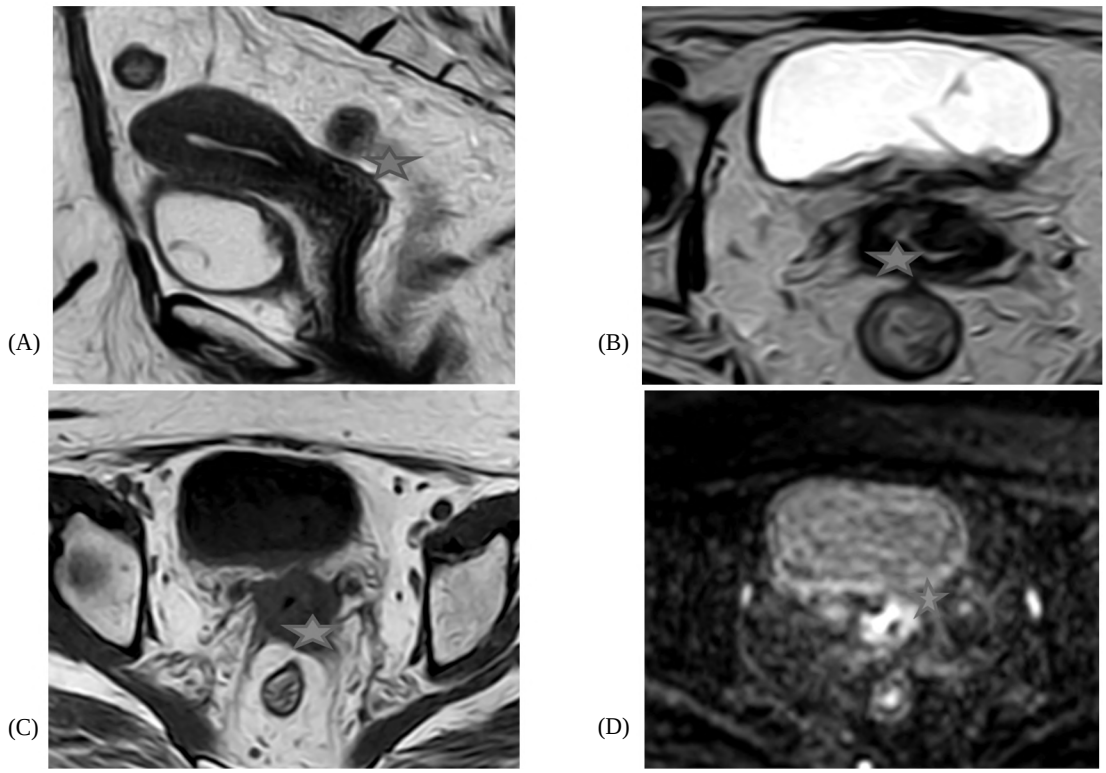


Fig. (9): MRI pelvis showing cervical carcinoma (Asterisk) (A,B) Sagittal and axial T2 WIs, (C) Axial T1 WIs, & (D) DWIs.

Discussion

Ultrasonography and MRI pelvis were the widely used investigations and the present study evaluates the accuracy of MR imaging in the detection and characterization of gynecological pelvic mass lesions **[5]**.

Unlike sonography excellent agreement was seen between MRI and the final proven origin of a mass. This stresses the importance of MRI as the best next step in evaluating such a mass before subjecting a patient to surgery that might be unnecessary **[6]**.

The present study was conducted on 30 female patients with gynecological pelvic masses which were studied by USG and MRI modalities.

Among 30 studied cases, 19 cases underwent surgical procedures and the excised tissue was subjected to histopathological examination for final diagnosis and the remaining 11 cases were managed conservatively. It was observed that almost one third (30%) patients had malignant pelvic mass lesions and (70%) had benign lesions.

In the present study, the age range of 18-71 years female patients were included who presented

with various clinical presentations, the main clinical presentations among patients were pelvic pain (80%), Pelvic mass (30%), irregular menses (10%), abdominal distention (6.7%), abnormal uterine bleeding (6.7%), post-menopausal bleeding (3.3%) and vaginal discharges (3.3%). In Mahmud et al., study found age ranged from 17 to 82 years and observed that majority (85.0%) of patients had pelvic discomfort/pain followed by 42.5% abnormal bleeding, & 30.0% pelvic mass [7].

MRI is superior to the US in evaluation of organ of origin, morphology and the site of adnexal lesions. In the present study, maximum number of lesions were seen arising from the ovaries (50 %), adnexal lesions (13.3%), uterine lesions (23.3%), cervical (10%), and vaginal lesions (3.3%). The origin of 2 lesions could not be made out by USG, whereas its origin was the ovaries by MRI findings. Similar to Sharma et al., study [8].

According to the size of the lesions on MRI, in our study we found that benign lesions (13.3%) were less than 5cm in size while (56.6%) were more than 5cm in size. The remaining 9 malignant lesions 2 (6.6%) were less than 5cm in size while 7 (23.3%) were more than 5cm in size, Similar to the study done by Anand and Sahu [9].

In our study we found that the composition of the masses by USG were found as: (43.3%) cystic (33.3%) solid & (26.7%) mixed. On MRI (40%) were cystic (33.3%) were solid (26.7%) were mixed. Most of the lesions showed cystic composition by US and MRI, Similar to the study done by Arunakumari and Chandra [6].

In this present study, among the benign lesions: There were 4 patients detected with uterine fibroid, 3 patients had ovarian endometrioma, 3 patients had hemorrhagic cysts, 3 patients had mature cystic teratoma, 2 patients had mucinous cystadenoma, 1 patient had serous cystadenoma, 1 patient had large simple ovarian cyst, 1 patient had tubo-ovarian abscess, 1 patient had tubo-ovarian torsion, 1 patient had para-ovarian cyst, & 1 patient had gartner duct cyst.

Among the malignant lesions there were 2 patients had endometrial adenocarcinoma, 1 patient had uterine leiomyosarcoma, 3 patients had ovarian epithelial carcinoma, & 3 patients had cervical squamous cell carcinoma. More or less similar to the study done by Yadav P [1].

In this study, according to the staging of malignant lesions by MRI, local invasion was detected in 66.7%, pelvic lymphadenopathy in 44%, peritoneal implants in 22%, ascites in 33%, and distant metastasis in 11 % cases. Unlike the study done by Ravikanth staging of malignant lesions by MRI found that local invasion was detected in 20% of the cases, pelvic lymphadenopathy in 6%, peritoneal implants in 12%, ascites in 26%, and distant metastasis in 2% cases [3].

According to the MRI diagnoses of gynecological pelvic masses compared to the gold standard in this current study, it was observed that true positive 8 cases, false positive 1 case, false negative 1 case and true negative 20 cases.

In Anwar et al., study showed true positive 14 cases, true negative 46 cases, false positive 2 cases and false negative 1 case [10].

According to the US diagnoses of gynecological pelvic masses in this present study compared to the gold standard, it was observed that true positive 6 cases, false positive 2 cases, false negative 2 cases and true negative 20 cases in diagnosis of gynecological pelvic mass.

In Kishan et al., study, the overall malignant lesions identified were 19 on histopathology, out of which 5 (true positive) were identified on USG and 14 (true positive) on MRI. Out of 31 definite benign lesions diagnosed on histopathology, 29 (true negative) were picked on USG and 31 (true negative) on MRI [5].

The present study would confer a sensitivity of 75%, specificity of 90.9%, positive predictive value (PPV) of 90.9%, negative predictive value (NPV) of 75% and accuracy of 68% to ultrasonography regarding diagnosis of the malignant gynecological pelvic mass lesions.

Studies conducted by Kishan et al., found that Ultrasonography showed sensitivity 26.3%, specificity of 93.5%, PPV of 80.3%, NPV of 55.9% and accuracy of 68% [5].

In this current study it was observed that MRI showed sensitivity 88.9% with Specificity 95.2% Accuracy 93.3%. PPV 88.9%. NPV 95.2%.

Studies done by Mahmud et al., the sensitivity was found 93.3%, Specificity was 92% Accuracy was 92.5%, PPV was 87.5%. NPV was 95.8% [7].

In Anwar et al., study showed the sensitivity and specificity of the imaging procedure for the assessment of malignant lesion, 93.3% and 95.8% respectively [10].

Conclusion:

In conclusion MRI is superior to ultrasound and can be used in difficult or equivocal cases, due to excellent depiction of the anatomy of the female pelvis and absence of ionizing radiation, MRI is an excellent tool for the assessment of disorders of the female pelvic organs. Ultrasound remains the first line of imaging female pelvis, but, however, MRI should be considered for better evaluation and better characterization of the pelvic pathologies.

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الأداء التشخيصى للتصوير بالرنين المغناطيسى فى تشخيص كتل الحوض النسائية

التصوير بالرنين المغناطيسى هو تقنية ممتازة لتقييم وتوصيف كتل الحوض النسائية، بسبب الدقة المكانية العالية، والتباين الممتاز فى الأنسجة، والقدرة على التصوير متعدد الأسطح. غالباً ما يستخدم التصوير بالرنين المغناطيسى لتكملة التصوير بالموجات فوق الصوتية.

\هدف الدراسة: لتقييم دقة التصوير بالرنين المغناطيسى فى الكشف عن آفات الكتلة النسائية وتوصيفها ودراسة الطبيعة المتنوعة لآفات كتل الحوض، لتحديد أصل ومحتوى الأنسجة وتوصيف كتل الحوض.

أجريت هذه الدراسة على ٣٠ مريضة بالغة يشتبه فى إصابتهن بكتلة نسائية فى الحوض بالفحص السريرى أو بالموجات فوق الصوتية، وقد تعرضن لتصوير الحوض بالرنين المغناطيسى، وبالتالى مقارنة نتائجهم بالمعيار الذهبى (نتائج تحليل الأنسجة الباثولوجية/متابعة التصوير بعد أخذ العلاج).

\النتائج: تفوق التصوير بالرنين المغناطيسى بشكل ملحوظ على الموجات فوق الصوتية فى تشخيص كتل الحوض وفى تقييم إمتداد الأورام، والانتشار المحلى للورم، كشف الغدد الليمفاوية المصابة، أظهر التصوير بالرنين المغناطيسى حساسية (٨٨.٩٪) فى تشخيص أورام الحوض النسائية، النوعية (٩٥.٢٪)، والدقة (٩٣.٣٪).

\الخلاصة: التصوير بالرنين المغناطيسى هو أداة ممتازة لتقييم اضطرابات أعضاء الحوض الأنثوية، وأفضل طريقة للكشف، وتوصيف الأمراض المختلفة، وتحديد مراحل المرضى الذين يعانون من الآفات الخبيثة حيث سيكون للتشخيص الدقيق تأثير على تخطيط الإجراءات الجراحية والطبية بالمقارنة معنا.