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Role of Magnetic Resonance Imaging in Diagnosis of the Sonographically Indeterminate Uterine Lesions

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ABSTRACT

Background: In fibroids MRI was more superior to transabdominal and transvaginal US in aiding their number and location.

Objective: This study aimed to define the role of magnetic resonance imaging in diagnosis of indeterminate uterine lesions after US examination. Gold standard is biopsy, surgery or follow up.

Subjects and methods: This prospective study was done through the period from September 2020 to December 2023 in the Diagnostic Radiology Department of Mansoura University Hospitals. Thirty–three patients were referred from the Gynecology Department to the Diagnostic Radiology Department. They were diagnosed with uterine lesions by ultrasound (US) but not finally diagnosed. Full clinical history was taken from every patient such as age, complain. All cases were examined by Magnetic Resonance Imaging (MRI).

Results: The MRI, demographic and obstetric history data, clinical examination and pathological analysis of the lesions nature were used for all study cases. The accuracy of the diagnosis of indeterminate uterine lesions after US examination by MRI was promising, and the results were significantly correlated with the pathological analyses, indicating that MRI can reflect the detailed and accurate information in patients with indeterminate uterine lesions, and contribute to the development of treatment regimens so that the patients can have a favourable prognosis.

Conclusion: We believe that MRI is the best modality for reflecting the detailed and accurate information in patients with indeterminate uterine lesions and contributing to the development of treatment regimens so that the patients can have a favorable prognosis.

Keywords: MRI, Ultrasound, Uterine lesions.

INTRODUCTION

Pelvic masses are difficult to diagnose. Evaluation of any lesion usually starts with clinical examination then imaging, or discovered incidentally at imaging for other clinical indications. For optimal management, reaching accurate diagnosis is essential, imaging is helpful for recommending the proper diagnosis or limiting the differential diagnosis and differentiating tumours from their mimics. Also, it is necessary for pre-surgical plane to assess mass size and location, assess the relation to pelvic structures **[1]**.

Some sonographic findings as endometrial thickness, heterogeneity and focal lesions are non-specific, with possibility of miss-diagnosis between benign and malignant disorders **[2]**. MRI is used to describe pelvic lesions in women based on the tissue type and its relations to the ovarian and uterine tissues. A lot of benign tumors were considered indeterminate on different US facilities as color Doppler and 3D US or CT **[3]**. MRI is the most effective diagnostic tool, owing to high contrast between structures in the female pelvis without exposure to radiation **[4]**. Functional or multi-parametric MRI offers molecular level details of tumor perfusion and cellularity, these techniques can demonstrate changes earlier following treatment **[5]**. Non-functional MRI offers excellent anatomic data of the uterus, but it mightn't distinguish some of the benign and malignant uterine lesions **[6]**.

Diffusion-weighted imaging (DWI) is a functional approach in MRI that can detect differences in water molecules mobility between normal tissues and tumors and discriminate benign and malignant lesions **[7, 8]**. Quantitative DCE-MRI assesses neovascularity and angiogenesis of tumors **[9]**. The MRI disadvantage is that it is not available readily. Also, it isn't necessary for the claustrophobic cases and patients that have specific metallic implants [10]. Therefore, this study was conducted to define MRI role in the diagnosis of indeterminate uterine lesions after US examination.

PATIENTS AND METHODS

This study was conducted to define the role of MRI in the diagnosis of indeterminate uterine lesions after US examination. The study included 33 patients who were referred from the Gynecology Department to The Diagnostic Radiology Department. They were diagnosed with uterine lesions by ultrasound but not finally diagnosed. Their ages ranged between 24 and 76 years with a mean age of 52 years.

All patients were imaged using external phased array surface coils on 1.5T superconducting magnet MRI machines. All enrolled patients met all inclusion criteria and none of the exclusion criteria. All cases were subjected to complete medical history, which included age, complaint, menstrual & obstetric history. Also, clinical examination, trans-abdominal & transvaginal US and pelvic MRI examination (including; axial and sagittal T2WI, axial T1WI, STIR, DWI & ADC) mapping as well as post-contrast MRI.

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Histo-pathological examination as a gold slandered for correlation with MRI data was done.

Ethical approval: The Ethics Committee of Mansoura Faculty of Medicine authorized this study. After receiving all of the information, each participant signed informed permission. The Helsinki Declaration was followed throughout the course of the investigation.

Statistical analysis

Data analysis was performed by SPSS software, version 25.0. Qualitative data were clarified using numbers and percentages. Quantitative data were clarified using mean ± Standard deviation for normally distributed data after testing normality using the Kolmogorov-Smirnov test. The significance of the results was set at ≤ 0.05 level.

RESULTS

Table (1) showed the demographic data, obstetric history and the clinical presentation in the study cases. The current study included 33 cases with a mean age of 52.3 ± 13.79 years with range from 24 to 76 years. The highest percentage of the cases (51.5%) were in the post-menopausal state. There were 30 married cases (90.9%). Moreover, there were 29 multipara cases (87.9%). The abnormal uterine bleeding (AUB) was the most frequent clinical presentation in the included cases in 19 cases (57.6%) followed by pelvic pain in 7 cases (21.2%) and pelvic abdominal swelling in 4 cases (12.1%). There were 3 cases who were accidentally discovered (9.1%).

Table (1): Demographic data and obstetric history in the study cases.

Variables		**Study cases (N = 33)**	
Age (years)	Mean ± SD	52.3 ± 13.79	
	Median (Range)	53 (24 – 76)	
		Number	**Percent**
Menopausal state			
Pre-menopausal		9	27.3
Peri-menopausal		7	21.2
Post-menopausal		17	51.5
Marital status			
Single		3	9.1
Married		30	90.9
Parity			
Nullipara		3	9.1
Multipara		29	87.9
Primipara		1	3.0
Clinical presentation			
Abnormal uterine bleeding		19	57.6
Pelvic pain		7	21.2
Pelvic abdominal swelling		4	12.1
Accidently discovered		3	9.1

Continuous data expressed as mean ± SD and median, Categorical data expressed as Number (%)

Table (2) showed the MRI criteria in the study cases. The apparent diffusion coefficient (ADC) value of the lesions as detected by MRI was 1.165 ± 0.371 with range from 0.450 to 1.950. The shape was round in 48.5 % and oval in 39.4 %.

The most affected site was intracavitary in 51.5%. Post-contrast MRI was positive in 31 cases (93.9%). Infiltration was positive in 10 cases (30.3%). Suspicious LNs was detected in 8 cases (24.2%). Metastases was detected in 4 cases (12.1%). The lesions were benign in 20 cases (60.6%) and malignant in 13 cases (39.4%).

Table (2): MRI criteria in the study cases

Variables		**Study cases N = 33**	
Anteroposterior diameter	Mean ± SD	7.42 ±4.09	
	Median (Range)	7.25 (0.7 – 17)	
Transverse diameter	Mean ± SD	7.69 ± 4.99	
	Median (Range)	6 (1.5 – 24)	
Height	Mean ± SD	8.16 ± 4.68	
	Median (Range)	8.55 (1.20 – 19)	
Endometrial thickness	Mean ± SD	2.17 ± 0.67	
	Median (Range)	2.5 (1.4 – 2.6)	
ADC (x 10^{-3} mm^2/s)	Mean ± SD	1.165 ± 0.371	
	Median (Range)	1.3 (0.450 – 1.950)	
		Number	**Percent**
Shape			
Rounded		16	48.5
Oval		13	39.4
Irregular		2	6.1
Lobulated		2	6.1
Site			
Intracavitary		17	51.5
Intramural		10	30.3
Subserosal		4	12.1
Submucosal		1	3.0
Query subserosal or adnexal		1	3.0

Continuous data expressed as mean±SD and median, Categorical data expressed as Number (%).

Continue Table (2): MRI criteria in the study cases

Variables	Study cases N = 33	
Border	N	%
Well-defined	27	81.8
Ill-defined	6	18.2
T1 MRI		
Low	22	66.7
Intermediate	3	9.1
Mixed	7	21.2
High	1	3.0
T2 MRI		
Low	5	15.2
Intermediate	10	30.3
Mixed	13	39.4
High	5	15.2
Post contrast MRI		
No	2	6.1
Yes	31	93.9
Infiltration		
No	23	69.7
Yes	10	30.3
Suspicious LNs		
No	25	75.8
Yes	8	24.2
Metastases		
No	29	87.9
Yes	4	12.1
Nature of the lesions		
Benign	20	60.6
Malignant	13	39.4

Continuous data expressed as mean ± SD and median, Categorical data expressed as Number (%)

Table (3) showed the diagnosis by MRI in the study cases. Leiomyoma was the most common diagnosis in 9 cases (27.2%) followed by endometrial carcinoma 5 cases. (15.1%).

Table (3): Diagnosis by MRI in the study cases

Variables	Study cases N = 33		Diagnostic accuracy
	Number	Percent	
CS ectopic scar	1	3.0	True negative
Endometrial carcinoma	5	15.1	True positive
Endometrial carcinoma with ovarian metastases OR Primary	1	3.0	True positive
Endometrial hyperplasia	2	6.1	True negative
Gestational trophoblastic disease	1	3.0	True negative
Giant endometrial polyp OR Cystic endometrial hype	1	3.0	True negative
Invasive mole	1	3.0	True positive
Large post wall fibroid, the possibility of sarcoma	1	3.0	True positive
Large uterine lesion for pathological correlation	1	3.0	True negative
Malignant uterine mass	3	9.1	True positive
Malignant cervical mass	2	6.1	True positive
Obstructed rudimentary uterine cornu	1	3.0	False positive
Ovarian lesion OR Subserous leiomyoma	1	3.0	True negative
Pedunculated Intrauterine mass OR pedunculated su	1	3.0	False negative
Polyp	1	3.0	True negative
Retained products of conception	2	6.1	True negative
Uterine leiomyoma	9	27.2	True negative

Categorical data expressed as Number (%)

Table (4) showed the nature of the lesions by pathological analysis in the study cases. The lesions were benign in 20 cases (60.6%), malignant in 12 cases (36.4%) and borderline in 1 case (3%).

Table (4): Nature of the lesions by pathological analysis in the study cases

Variables	Study cases (N = 33)	
Nature of the lesions	N	%
Benign	20	60.6
Malignant	12	36.4
Borderline	1	3.0

Categorical data expressed as Number (%)

Table (5) showed the comparison of the benign and malignant lesions as regards the MRI criteria in the study cases.

Regarding the MRI findings, the comparison between the cases regarding the pathological nature of the lesions showed that the ADC was statistically significantly higher in the benign tumors.

There was insignificant difference in T1 SI between benign vs. malignant lesions. There was a significant difference in T2 SI between benign vs. malignant lesions.

Table (5): Comparison of the benign and malignant lesions as regards the MRI criteria in the study cases

Items	Benign [N=20]	Malignant [N=12]	Borderline [N=1]	Test of Sign.
Shape				
Rounded	11 (55%)	5 (41.7%)	0 (0%)	$\chi2$= 6.621 P = 0.357
Oval	7 (35%)	5 (41.7%)	1 (100%)	
Irregular	2 (10%)	0 (0%)	0 (0%)	
Lobulated	0 (0%)	2 (16.7%)	0 (0%)	
Anteroposterior diameter	7.65 (1.7 -17)	6 (0.7 -12)	15	KW = 2.926 P = 0.232
Transverse diameter	7.25 (1.5 -20)	5.7 (1.5 -10)	24	KW = 4.464 P = 0.107
Height	8.55 (1.2 -19)	5 (1.4 -11.5)	18	KW = 4.464 P = 0.107
Endometrial thickness	2 (1.4 -2.6)	2.5		KW = 0 P = 1
ADC (x 10^{-3} mm^2/s)	1.348 ±0.231	0.856 ± 0.376	1.2	**F = 10.586 P < 0.001***
Border				
Well defined	18 (90%)	8 (66.7%)	1 (100%)	MC =2.974 P = 0.226
Ill defined	2 (10%)	4 (33.3%)	0 (0%)	
T1 MRI				
Low	12 (60%)	10 (83.3%)	0 (0%)	**MC = 35.259 P < 0.001***
Intermediate	2 (10%)	1 (8.3%)	0 (0%)	
Mixed	6 (30%)	1 (8.3%)	0 (0%)	
High	0 (0%)	0 (0%)	1 (100%)	
T2 MRI				
Low	5 (25%)	0 (0%)	0 (0%)	MC = 10.103 P = 0.120
Intermediate	3 (15%)	7 (58.3%)	0 (0%)	
Mixed	9 (45%)	3 (25%)	1 (100%)	
High	3 (15%)	2 (16.7%)	0 (0%)	
Post contrast MRI	18 (90%)	12 (100%)	1 (100%)	MC = 1.384 P = 0.501
Infiltration	1 (5%)	9 (75%)	0 (0%)	**MC = 17.849 P < 0.001***
Suspicious LNs	0 (0%)	8 (66.7%)	0 (0%)	**MC = 18.840 P < 0.001***
Metastases	0 (0%)	4 (33.3%)	0 (0%)	**MC = 7.966 P < 0.001***

KW = Kruskall Wallis test F: Fischer's exact test MC: Montecarlo test *: Statistically significant (p< 0.05)

The infiltration, suspicious LNs, and metastases were significantly higher in the malignant lesions. Table (6) showed diagnostic value of ADC (x 10^{-3} mm^2/s) to identify cases with malignant lesions by pathology in the study cases. The best cutoff point of ADC to identify malignant lesions was < 1.065 x 10^{-3} mm^2/s with 91.7% sensitivity, 95.2% specificity, 89.6% NPV, 93.6% PPV and 94.3% accuracy (Table 6).

Table (6): Diagnostic value of ADC [x10^{-3} mm^2/s] to identify cases with malignant lesions by pathology

Diagnostic criteria	ADC [x 10^{-3} mm^2/s]
AUC	0.889
Cut off point	< 1.065
Sensitivity	91.7 %
Specificity	95.2 %
NPV	89.6 %
PPV	93.6 %
Accuracy	94.3 %
P	**< 0.001***

AUC: area under the curve. NPV: Negative predictive value.
PPV: Positive predictive value P: probability.
*: significant p value (< 0.05).

Table (7) showed the correlation between MRI and pathological findings in detection of the natures of the lesions in the study cases. There was a strong statistically significant agreement between MRI and pathology in detection of the nature of the lesions. MRI showed 100% sensitivity, 95% specificity, 96.9% accuracy, 92.3% PPV and 100% NPV as compared to pathology in detection of malignant lesions.

Table (7): Correlation between MRI and pathological findings in detection of the natures of the lesions in the study cases

Items	Pathological findings				Agreement analysis
	Benign (n= 20)		Malignant (n= 12)		
	No	%	No	%	
Diagnosis by MRI					
Benign (N=19)	19 (TN)	95	0 (FN)	0	**κ= 0.876 P < 0.001***
Malignant (N=13)	1 (FP)	5	12 (TP)	100	
Sensitivity	100 %				
Specificity	95 %				
Accuracy	96.9 %				
PPV	92.3 %				
NPV	100 %				

κ: Kappa agreement coefficient *: Statistically significant (p < 0.05).

DISCUSSION

Ultrasound is one of the frequently used methods to evaluate the pathology of female pelvis, owing to the prompt availability, low costs as well as safety and simple examination. MRI can be used instead due to the limited view field, pelvic obscuration by the bowel gases and US dependence on the radiologist's skill, MRI is demonstrated to be more accurate and many times gold standard compared to US. In fibroids MRI was more superior to transabdominal and transvaginal US in aiding their number and location [10, 11].

Both US and MRI had the same sensitivity in detecting malignancy, while MRI was better in evaluating the staging and depth of myometrial/parametrial affection. MRI is an outstanding modality in characterization of female pelvic mass lesions, distinguishing neoplastic from non-neoplastic disorders, benign from malignant tumors, and to determine origin of the lesion in case of indeterminate diagnosis on US [12, 13].

DWI visualizes the variability in mobility of water secondary to changes in tissue cellularity, fluid viscosity, and cell membrane integrity. The higher signal intensity generated on DWI, the more restricted water movement. Numerous recent researches reported the value of DWI to distinguish endometrial carcinoma from normal endometrium or a benign lesion. The apparent diffusion coefficient (ADC) could offer quantitative degree of diffusion. So, an ADC map presents lower ADC values, and higher DWI signal intensity in the majority of tumors when compared to normal tissue [14].

Combining DWI and conventional MRI is valuable for assessing myometrial invasion in endometrial cancer, and to differentiate cancer from benign tumors as fibroids and adenomyosis [15]. In the present study, lesions were evaluated by site, size, degenerative changes in lesions and the lesion extent, which was conducted by using the US and MRI. The final diagnoses by the imaging were compared to the histopathological examination.

AUB is a frequent gynaecologic problem. It can be caused by functional or structural disorders, but it shouldn't be underestimated. In postmenopausal females with AUB, there is a 10% risk of endometrial carcinoma, but this risk falls below 1% if endometrial thickness (ET) < 4 mm was shown by TVS. In premenopausal women with AUB, the predictive performance of ET revealed contradictory outcomes by **Giannella *et al.*** [16].

The current study included 33 cases with mean age of 52.3 ± 13.79 years and age range between 24 and 76 years. There were 30 married cases (90.9%). Moreover, there were 29 cases multipara (87.9%). According to the menopausal state 17 (51.5%) of the cases were in the post-menopausal state. According to the clinical presentation, abnormal uterine bleeding (AUB) was the most common clinical presentation in the included cases in 19 cases (57.6%) followed by pelvic pain in 7 cases. These findings are similar to previous study by **Abd-Aljabbar *et al.*** [10] in which, 24 out of total 41 (58.5%) showed abnormal bleedings, 6 out of total 41 (14.4%) complained of pain and 9 out of total 41 (22.0%) complained of pain and bleeding complains.

MRI assessment among the studied cases determined that leiomyoma was the commonest finding, 10 out of total 33 cases (30.3%). These findings are closer to **Abdel Wahab *et al.*** [17] study in which, 7 out of total 25 had myomas (28%).

The present study revealed strong statistically significant association between MRI and pathology in detecting nature of the lesions. MRI showed 100% sensitivity, 95% specificity, 96.9% accuracy, 92.3% PPV and 100% NPV as compared to pathology in detection of malignant lesions. Such results are in accordance with previous study by Solyman et al. [14] in which MRI sensitivity for uterine pathologies was 100% and specificity was 82.6%, agreed with Yadav [18] in which, sensitivity of MRI for detection of lesions was 100% and specificity was (98.4%) in contrast. The current study disagrees with **Ahmad *et al.*** [19] who displayed that the sensitivity and specificity were 78.75% and 63.64% respectively.

In our study, the highest percentage of the cases 17 (51.5%) were in the post-menopausal state, and 16 (48.5%) in pre-menopausal state. These findings differed from that of **Bhatnagar *et al.*** [11] where 37 patients (82%) were in the premenopausal group and the rest of them were postmenopausal. Also, **Shankar *et al.*** [20] reported that most of the cases (68%) were in the premenopausal phase, whereas only few were in the postmenopausal phase (32%).

In the current study US diagnosis showed that 15 of the 20 pathologically benign tumors were also diagnosed as benign by US. Most pathologically malignant lesions (11/12, 91.7%) were also diagnosed as malignant by US. Therefore, there was good agreement between US diagnosis and pathological diagnosis (kappa = .625, p<.001). Accordingly, the US has 91.7% sensitivity, 75% specificity, 68.8% PPV, 93.8% NPV, and 81.3% overall accuracy in diagnosing malignant nature of the lesion. These findings disagree with **Kishan *et al.*** [21]**,** in which, the US had a sensitivity of 26.3%, specificity of 93.5%, PPV of 80.3%, NPV of 55.9% and accuracy of 68%.

In the current study 20 cases (60.6%) were benign, 12 cases (36.4%) were malignant and 1 case (3%) was borderline and proved by pathological diagnosis. These outcomes are in the same line with **Bhatnagar *et al.*** [11] in which, 30 cases (67%) had benign tumors and 10 cases had malignant tumors. Also, close to **Shaha *et al.*** [13] where 28 (58.3 %) had benign tumors and cases 20 (41%) had malignant lesions.

In current study 27 cases (81.8 %) were well defined, 6 cases (18.2%) were ill defined. These findings disagree with **Shaha *et al.*** [13] in which 24 cases (50 %) were well defined. In current study the best cutoff point of ADC to identify malignant tumors was < 1.065 x 10-3 mm2/s with 91.7% sensitivity, 95.2% specificity. These finding are similar to **Srikanth *et al.*** [22] where ADC cutoff value for malignant tumor was 1.05×10^{-3} mm2/s with a sensitivity of 85.71% and specificity of 98.04%, which agree with **Kilickesmez *et al.*** [23] in which cut-off value for malignant tumors was 1.05×10^{-3} mm2/s with a sensitivity of 95.83% and specificity of 94.55%. Also, close to Fuji et al. [25] in which the cut off value to distinguish benign from malignant tumors was 1.15 x10–3 mm2 /s with a sensitivity of 84.6% and specificity of 100%, which disagree with **Balaban *et al.*** [24] in which cut off value to differentiate benign from malignant tumors was 0.9x10–3 mm2 /s with a sensitivity of 57% and a specificity of 91%.

CONCLUSION

Finally, the accuracy of the diagnosis of indeterminate uterine lesions after US examination by MRI is promising, and the results were significantly correlated with the pathological analyses, indicating that MRI could reflect the detailed and accurate information in patients with indeterminate uterine lesions, and contributed to the development of treatment regimens so that the patients can have a favourable prognosis.

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