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Role of Preoperative DWI-MRI and Dynamic Contrast Enhanced MRI in Predicting Aggressive Disease in Endometrial Carcinoma

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Abstract

Background: Endometrial cancer is the most common gynecologic cancer seen in women today, It is more prevalent in high-resource countries, but its incidence is rising in low-resource countries as a result of rising obesity and improved longevity.

Aim of Study: The purpose of this study is to evaluate the accuracy of DWI and dynamic contrast enhanced MRI in preoperative staging of endometrial carcinoma and prediction of severity of the disease prior to surgery.

Patients and Methods: The study included 20 patients referred from the Gynecology Department to the Radiology Department in Ain Shams University Hospitals from October 2020 to July 2021. They were all presented with postmenopausal bleeding or menorrhagia.

Results: The current study showed that as regard MRI signal characteristics in the studied group; 45% were isointense in relation to myometrium on T2WI. 100% revealed high signal intensity (restricted diffusion) on DWI. 100% had ADC value $<1.2 \times 10^{-3} mm^2/s$. There was no significant association between histological grade of endometrial carcinoma and the ADC value of each grade. There was highly significant difference between MRI Staging and Surgical Staging. There was no significant difference between MRI findings and Surgical Findings.

Conclusion: DCE-MRI and DWI represent valuable supplements to conventional MRI by providing preoperative imaging biomarkers that predict aggressive disease in endometrial cancer patients.

Key Words: *Preoperative DWI-MRI – Dynamic contrast – MRI – Predicting aggressive disease – Endometrial carcinoma.*

Introduction

ENDOMETRIAL cancer is the most common gynecologic cancer seen in women today, It is more prevalent in high-resource countries, but its incidence is rising in low-resource countries as a result of rising obesity and improved longevity **[1]**.

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Most endometrial cancer occurs in postmenopausal women over the age of 50 years (median age of 63 years) who commonly present with vaginal bleeding. Less commonly the presentation is associated with vaginal discharge, while abdominal distension and pain are usually associated with advanced disease **[2]**.

Endometrial cancer is curable, especially in the early stages. Endometrioid histology has better prognosis than non endometrioid histologies. Surgery is the mainstay of treatment. Adjuvant radiotherapy and systemic chemotherapy play a role in selected cases. Accurate mapping of the extent of cancer spread is important for appropriate application of local and/or regional treatment. Although endometrial cancer is surgically staged, the identification of disease extent in particular extrauterine spread prior to surgery is important to optimize treatment planning **[2]**.

MRI is the best tool for preoperatively assessing myometrial invasion depth and cervical involvement which correlate with tumor grade, presence of LN metastases, and overall survival. The American College of Radiology recommends MRI as the preferred imaging modality for treatment planning **[3]**.

The combination of T2-weighted imaging (T2WI), dynamic contrast-enhanced (DCE) MR imaging, and diffusion-weighted imaging (DWI) offers the best diagnostic accuracy in staging of endometrial cancer **[4]**.

Conventional pelvic MRI provides information on tumor size, myometrial invasion, cervical stroma invasion, and suspicion of pelvic lymph node metastases, together indicative of the tumor's aggressiveness **[5]**.

Diffusion-weighted imaging (DWI) measures the microscopic mobility of water molecules in

the tissue. The diffusion properties are highly influenced by tissue microstructure, microcirculation, and cellular density [6].

On T2-weighted images (T2WIs), tumors may demonstrate a heterogeneous signal intensity but are most commonly hyperintense relative to the myometrium. Contrast enhanced MRI plays a major role in detection of the tumor and assessing the depth of myometrial invasion. Endometrial cancers enhance less than the surrounding myometrium on the post contrast T1WI images with resultant increased distinction between the tumor and the myometrium during the equilibrium and portal venous phases allowing for visualization of smaller tumors [7].

Aim of the study:

The purpose of this study is to evaluate the accuracy of DWI and dynamic contrast enhanced MRI in preoperative staging of endometrial carcinoma and prediction of severity of the disease prior to surgery.

Patients and Methods

Patients:

The study included 20 patients referred from the Gynecology Department to the Radiology Department in Ain Shams University Hospitals from October 2020 to July 2021. They were all presented with postmenopausal bleeding or menorrhagia.

Inclusion criteria:

Patients presented with a histologic diagnosis of endometrial carcinoma.

Exclusion criteria:

1- Patients with any Contraindications to MRI e.g. Brain aneurysm clips, pacemakers, certain artificial heart valves, inner ear (cochlear) implants, recently placed artificial joints, some older types of vascular stents and orbital F.B.

2- Patients treated with chemotherapy, patient with kidney disease, previous pelvic gynecological surgery, and contraindications to the contrast media.

History and investigations:

All cases were subjected to the following:

- Full history taking with a special emphasis on: Age, parity, age of menarche, duration of menopause if applicable, history of replacement hormonal therapy or contraceptive therapy, previous gynecological problem or pervious curettage, history of systemic disease or anticoagulant therapy, routine laboratory investigation for all patients including complete blood picture, random blood sugar, liver and kidney functions.
- Patient preparation: The patients voided 30 to 60 minutes before the examination since the full bladder may degrade T2-weighted MR images, and they were fasting for 4-6 hours before the procedure with administration of anti-peristaltic agent to reduce artifact from small bowel peristalsis

Methods:

The type of study was a cross sectional study and the study period was 6-12 months.

Image interpretation:

MR images analysis for following parameters: Thickness of the endometrium, tumor signal intensity on T2-weighted image compared with that of adjacent myometrium, myometrial invasion, uterine enhancement pattern at dynamic images, downward extension, extra uterine extension and distant metastasis, lymph node assessment, ADC (Apparent Diffusion Coefficient) value measurement. In DCE-MRI, imaging was acquired at 0,30,60,90 and 120 seconds post contrast.

Staging analysis:

Using a combination of MR imaging sequences in the staging of endometrial carcinoma following the FIGO staging analysis.

Statistical analysis:

Data were collected, coded, revised and entered to the Statistical Package for Social Science (Rstudio) version 2.3.2. The data were presented as number and percentages for the qualitative data, mean, standard deviations and ranges for the quantitative data with parametric distribution and median with inter quartile range (IQR) for the quantitative data with non-parametric distribution. The p-value was considered significant as the following: $p>0.05$: Non-significant (NS), $p<0.05$: Significant (S), $p<0.01$: Highly significant.

Results

Table (1): Distribution of age between the studied group.

Age			
	Range	Mean ± SD	Median (IQR)
	32-78 years	58.45±11.49	59.5 (52.5-65.75)
Age range			
	No. (n=20)		(%)
≤50	4		20
>50	16		80
Total	20		100

Table (1) shows distribution of age in our studied group. The mean age of patients was 58.45 ± 11.49 years and ranged from 32 to 78 years. 16 (80%) patients were more than 50 years while 4 (20%) were less than 50 years.

Table (2): Distribution of histological type between the studied group.

Histological type	No. (n=20)	(%)
Endometrioid adenocarcinoma	18	90
Undifferentiated carcinoma	2	10

Table (2) illustrates distribution of histological type between the studied group. The majority of patients (90%) had Endometrioid adenocarcinoma while only 10% had Undifferentiated carcinoma.

Table (3): Distribution of tumor grade between the studied group.

Grade of tumor	No. (n=20)	(%)
Grade I adenocarcinoma (well differentiated)	8	40
Grade II adenocarcinoma (moderately differentiated)	7	35
Grade III adenocarcinoma (undifferentiated)	5	25

Distribution of tumor grade between the studied group was illustrated in Table (3). 8 (40%) patients had Grade I adenocarcinoma (well differentiated), 7 (35%) patients had Grade II adenocarcinoma (moderately differentiated) and 5 (25%) patients had Grade III adenocarcinoma (undifferentiated).

Table (4): MRI signal characteristics in the studied group.

	No. (n=20)	(%)
T2 signal intensity in relation to myometrium:		
Hypo intense	7	35
Isointense	9	45
Hyper intense	4	20
DWI:		
High signal intensity (restricted)	20	100
Low signal intensity	0	0
ADC value:		
$<1.2 \times 10^{-3} mm^2/s$	20	100
$\geq 1.2 \times 10^{-3} mm^2/s$	0	0

Table (4) shows MRI signal characteristics in the studied group. Regarding T2 signal intensity in relation to myometrium. 45% cases were isointense, 35% cases were hypointense and 20% cases were hyperintense. As regards to DWI, all cases (100%) had high signal (restricted) intensity. Also, all cases (100%) had mean ADC value less than $<1.2 \times 10^{-3} mm^2/s$.

Table (5): Association between histological grade of endometrial carcinoma and the ADC value of each grade.

	ADC Mean ± SD	p	p_1	p_2	p_3
Grade I	0.87±0.20	0.961	0.99	0.97	0.96
Grade II	0.88±0.14				
Grade III	0.85±0.16				

p: V of ANOVA. p2: Grade I, Grade III.
p 1: Grade I. Grade II. p3: Grade II, Grade III.

Table (5) shows association between histological grade of endometrial carcinoma and the ADC value of each grade. The mean ADC value in grade I, grade II and grade III was 0.87 ±0.20, 0.88±0.14 and 0.85±0.16 respectively. there was no statistically significant difference between histological grade regarding ADC value.

Table (6): Distribution of all cases according to MRI staging and surgical staging (n=20).

Staging	MRI No. (%)	Surgical No. (%)	Fisher test
IA	6 (30.0%)	4 (20.0%)	p=0.0001*
IB	5 (25.0%)	7 (35.0%)	
II	2 (10.0%)	1 (5.0%)	
IIIA	1 (5.0%)	2 (10.0%)	
IIIB	2 (10.0%)	2 (10.0%)	
IIIC	3 (15.0%)	3 (15.0%)	
IIIIB	1 (5.0%)	1 (5.0%)	

Table (6) shows distribution of all cases according to MRI Staging and Surgical Staging. It was noticed that there was high significant difference between MRI staging and surgical staging (p= 0.0001).

Table (7): Distribution of all cases according to MRI findings and surgical finding (n=20).

Findings	MRI No. (%)	Surgical No. (%)	Fisher test
Cervical invasion	7 (35.0%)	6 (30.0%)	p=0.99
Deep myometerial invasion	13 (65.0%)	14 (70.0%)	
Distant metatsis	1 (5.0%)	1 (5.0%)	
Lymph node metastatic	6 (30.0%)	5 (25.0%)	
Serosal invasion	4 (20.0%)	2 (10.0%)	
Superfacial myometerial invasion	7 (35.0%)	6 (30.0%)	
Vaginal invasion	2 (10.0%)	2 (10.0%)	
Parameterial invasion	4 (20.0%)	4 (20.0%)	
Adnexa	1 (5.0%)	1 (5.0%)	

Table (7) shows distribution of all cases according to MRI and Surgical finding. It was noticed that there was no significant difference between MRI and surgery regarding findings (p=0.99).

Table (8): Distribution of all studied cases according to Operative findings.

	No. (n=20)	(%)
Intra-abdominal metastasis:		
No	20	100
Yes	0	0
Lymph nodes:		
Free	15	75
Positive	5	25
Adenxa:		
Free	19	95
Positive	1	5
Ascites:		
No	18	90
Yes	2	10

Table (8) shows distribution of all studied cases according to Operative findings. All cases (100%) had no intra-abdominal metastasis. 25% cases showed positive lymph nodes. One case had positive adnexa and two (10%) cases had ascites.

Table (9): Accuracy measures of (DWI-MRI/DCE MRI) in grading of Lymph node in relation to histopathology.

Grading of Lymph node (MRI)	Surgical finding: Positive (n=5) No.	%	Negative (n=15) No.	%	Total	Sensitivity	Specificity	PPV	NPV	Accuracy
Positive	5	25	1	5	6	100%	93.3%	83.3%	100%	95%
Negative	0	0	14	70	14					
Total	5	25	15	75	20 (100%)					

Based on Surgical Finding as a reference standard, MRI identified the grading of lymph node in 5 patients (true positives). MRI modalities did not detect grading of lymph node in one patient (true negatives).

We found that MRI had overall sensitivity, specificity, and diagnostic accuracy of 100%, 93.3% and 95% respectively in detecting grading of lymph node in our patients.

Table (10): Accuracy measures of (DWI-MRI/DCE MRI) in assessment of Cervical invasion in relation to histopathology (n=20).

Cervical invasion (MRI)	Surgical finding: Positive (n=6) No.	%	Negative (n=14) No.	%	Total	Sensitivity	Specificity	PPV	NPV	Accuracy
Positive	6	30	1	5	7	100%	92.86%	85.71%	100%	95%
Negative	0	0	13	65	13					
Total	6	30	14	70	20 (100%)					

Based on Surgical Finding as a reference standard, MRI identified the cervical invasion in 6 patients (true positives). MRI modalities did not detect cervical invasion in one patient (true negatives).

We found that MRI had overall sensitivity, specificity, and diagnostic accuracy of 100%, 92.86% and 95% respectively in detecting cervical invasion in our patients.

Table (11): Accuracy measures of (DWI-MRI/DCE MRI) in assessment of deep myometrial invasion in relation to histopathology (n=20).

Deep myo-metrial invasion (MRI)	Surgical finding: Positive (n=6) No.	%	Negative (n=14) No.	%	Total	Sensitivity	Specificity	PPV	NPV	Accuracy
Positive	13	65	0	0	13	92.86%	100%	100%	85.71%	95%
Negative	1	5	6	30	7					
Total	14	70	6	30	20 (100%)					

Based on Surgical Finding as a reference standard, MRI identified the deep myometrial invasion in 13 patients (true positives). MRI modalities did not detect deep myometrial invasion in one patient (true negatives).

We found that MRI had overall sensitivity, specificity, and diagnostic accuracy of 92.86%, 100% and 95% respectively in detecting deep myometrial invasion in our patients.

Based on Surgical Finding as a reference standard, MRI identified the superficial myometrial invasion in 6 patients (true positives). MRI modalities did not detect superficial myometrial invasion in one patient (true negatives).

We found that MRI had overall sensitivity, specificity, and diagnostic accuracy of 100%, 92.86% and 95% respectively in detecting superficial myometrial invasion in our patients.

Table (12): Accuracy measures of (DWI-MRI/DCE MRI) in assessment of Superfacial myometrial invasion in relation to histopathology.

Superficial myometrial invasion (MRI)	Surgical finding				Total	Sensitivity	Specificity	PPV	NPV	Accuracy
	Positive (n=6)		Negative (n=14)							
	No.	%	No.	%						
Positive	6	30	1	5	7	100%	92.86%	85.71%	100%	95%
Negative	0	0	13	65	13					
Total	6	30	14	70	20 (100%)					

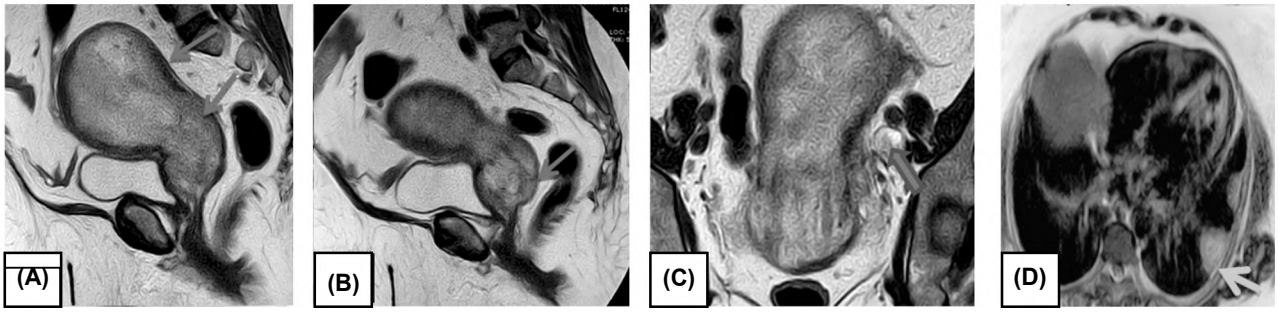
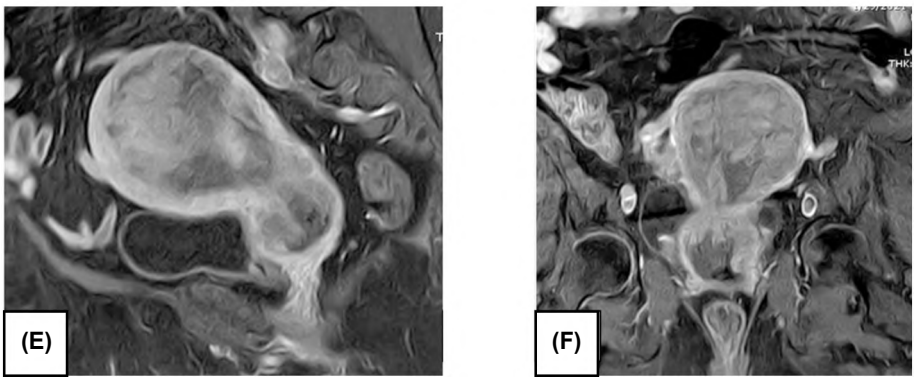
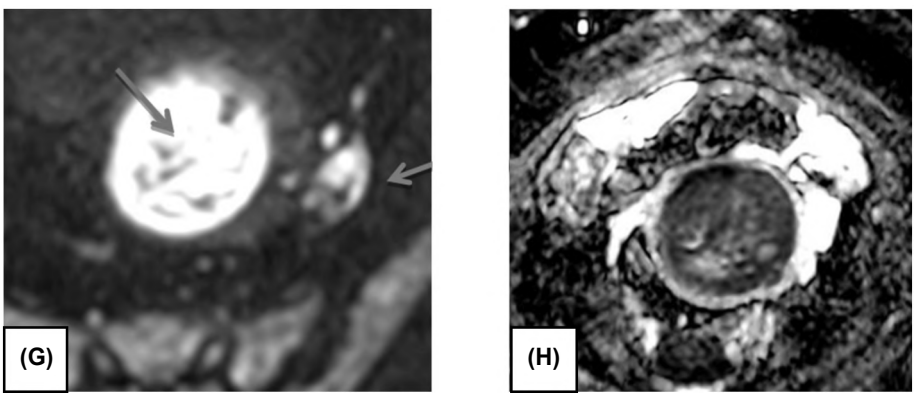


Fig. (1): 63 years old female patient presented with vaginal bleeding for 5 days duration, TVUS revealed bulky uterus with endometrial soft tissue mass extending to the cervix. MRI was ordered to confirm diagnosis and for preoperative staging. MRI examination showed: Coronal (A) and Saggital (B&C) T2 images showing enlarged uterus by soft tissue mass invading the entire myometrium, extending to the uterine cervix and the upper third of vaginal canal measuring about 14.3 x 8.5 x 7.5 cm dispalying hyper intense signal in T2 (red arrows), enlarged left external iliac lymph node measuring about 34 x 20 mm showing internal cystic changes (blue arrow). Axial T2 upper abdomen/lower chest cutts (D) Showing multiple lower lobar pleural based lung nodules, the largest is seen at the lateral basal segment of the left lower lung lobe measuring about 26 mm in diameter (green arrow).



Coronal (E) and Sagital (F) T1 post contrast images showing mild heterogenous enhancement of the mass.



Diffusion weighted image (DWI) and coresponding ADC map showing true diffusion restriction of the mass (G & H) (red arrow) with bright high signal intesity of the left extternal iliac lymph node (blue arrow) (G) and low signal in ADC map.

Final diagnosis:

- The uterus is enlaged with large heterogenous soft tissue mass lesion seen filling the entire endometrial cavity and invading the entire myometrium, yet still confined by the serosa, it is seen inilterating the uterine cervix as well as the upper third of vaginal canal with signifigant heterogenous restricted diffusion and mild post contrast enhancement.
- Associated enlarged malignant looking external iliac lymph nodes showing true diffusion restriction and internal cystic changes.
- Multiple lower lobar pleural based lung nodules mostly metastatic.
- Stage IVB disease.

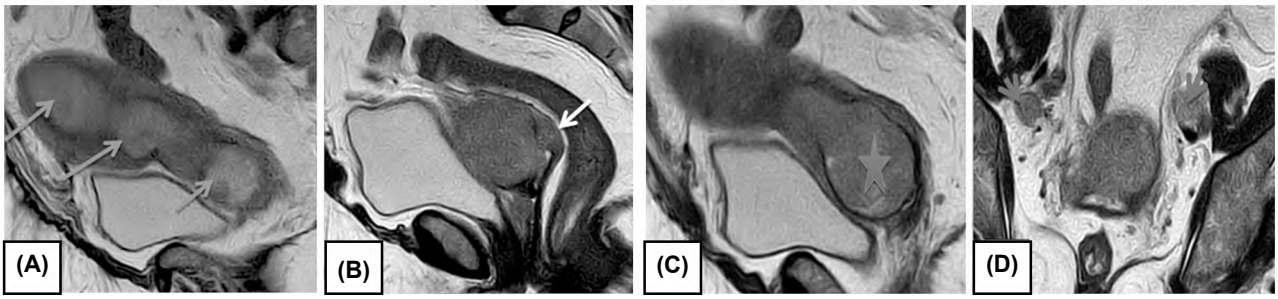
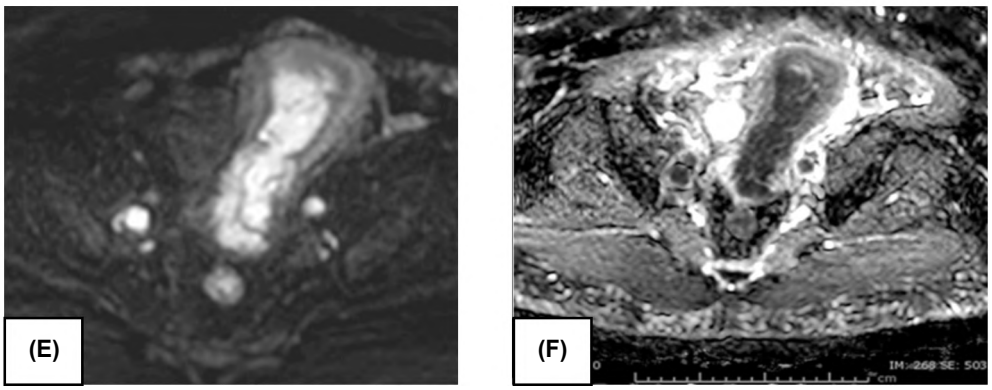
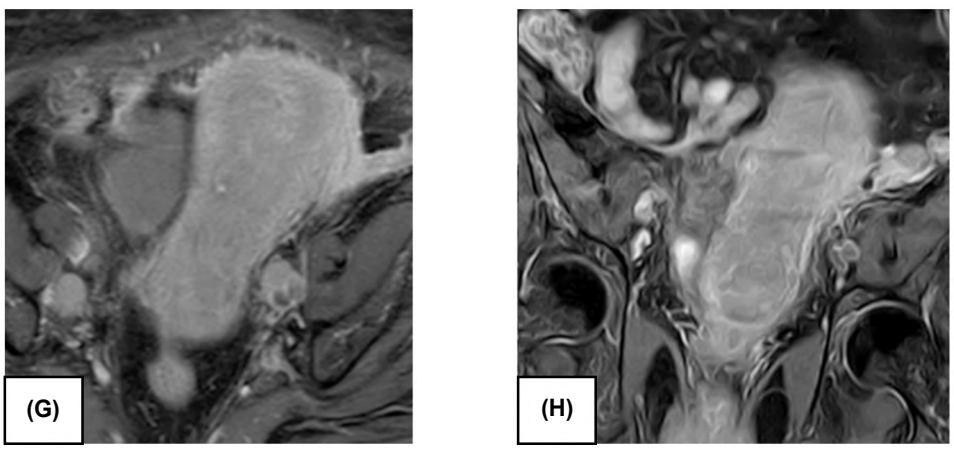


Fig. (2): 62 years old female patient with post menopausal uterine bleeding for one month,Ultrasound was done and revealed ballooning of the cervix and cervical canal. MRI was ordered for diagnosis and preoperative staging, MRI examination showed: Saggital (A,B,C) and coronal (D) T2 images showing: Large irregular endometrial soft tissue mass expanding the endometrium and interrupting the tranzitional zone at the lower uterine segment (A) (blue arrow), displaying isointense signal on T2 images, it is seen extending to the uterine cervix causiing it's enlagment and it is seen interrupting and invading the circumferential hypointense cervical ring (mainly anterior, right lateral and posterior) (C) (blue star)and exhibiting right parametrial invasion on the right side.

It also shows involvement of the upper third of vagina (B), the tumor shows invasion of right mesorectal fascia, yet preserved line of fat between the tumor and the rectum (B) (Yellow arrow). Multiple enlarged lymph nodes are seen involving bilateral external iliac and common iliac groups, the largest is seen at the left external iliac group measuring about 22 x24 mm (D) (arrow heads).



Diffusion weighted image and ADC map showing true diffusion restriction of the mass with bright high signal intensity (E) and low signal in ADC map (F).



Axial and coronal T1 post contrast images showing mild post contrast enhancement of the mass.

Final diagnosis:

- Large endometrial soft tissue mass showing true diffusion restriction and post contrast enhancement with cervical, parametrial and mesorectal fascia invasion (stage IIIC 1 disease).
- Associated multiple enlarged external iliac and common iliac lymph nodes, mostly metastatic.

Discussion

Endometrial cancer (EC) is the most common malignant tumor of the female genital tract in Western countries. Most cases are diagnosed at an early stage, and 75% occur in postmenopausal women (>50 years) with vaginal bleeding being the main symptom. Risk factors include conditions promoting increased estrogen exposure, such as hormonal replacement therapy, obesity, tamoxifen use, early menarche, late menopause, nulliparity, history of polycystic ovary disease, and hereditary non-polyposis colorectal cancer (Lynch syndrome type 2) [3].

Endometrial cancer is the most common pelvic gynecologic malignancy in industrialized countries and the incidence is increasing. Primary surgical treatment is currently guided by putative preoperative risk based on curettage/biopsy yielding histological subtype and grade, and on diagnostic imaging evaluating local tumor extent and distant spread. However, these preoperative assessments have reported limitations in reproducibility and accuracy when compared to the gold standard being the final surgico-pathological International Federation of Gynecology and Obstetrics (FIGO) stage [8].

Endometrial Carcinoma (EC) is the sixth most frequent malignancy in females worldwide and the most frequent gynecological cancer in Western countries. It is typical of the postmenopausal age, occurring in about 90% of cases after the age of 50, with an average age at diagnosis of about 63 years [9].

The prevalence of endometrial cancer is increasing due to an aging population combined with rising levels of obesity. The overall 5-year survival of endometrial carcinoma is 80%, ranging from 20 to 91 % for different tumor stages. Approximately 75% of endometrial carcinomas are diagnosed with the tumors confined to the uterine corpus. Moreover; 75% of cases occur in postmenopausal women, with the median age at diagnosis being 70 years. Adeno-carcinomas account for 90% of endometrial neoplasm, whereas uterine sarcomas are relatively rare and account for only 2%-6%; the remaining histologic types include adeno-carcinoma with squamous cell differentiation and adeno-squamous carcinoma [10].

Robust imaging technology is continuously evolving to improve preoperative treatment planning. Magnetic resonance imaging (MRI) has superior performance than ultrasonography and computed tomography (CT) for detecting the myometrial invasion, with advanced capability beyond the visualization of different aspects of the anatomical structures. Diffusion-weighted imaging (DWI) measures the Brownian motion of molecules and highlights the increased cellularity of cancer tissue through quantitative evaluation using the apparent diffusion coefficient (ADC) map. Dynamic contrast enhancement (DCE)-MRI utilizes the intravenous gadolinium-based contrast agent which is contained in the healthy blood vessel by means of the functional tightjunction but leaks out through the process of neovascularization in the tumor, thus providing adequate model of the blood flow, extraction fraction, blood volume, volume of extra vascular extracellular space, capillary permeability surface area product, and transfer from the blood to tissue. The magnetic resonance spectroscopy (MRS) technique enables semi-quantitative assessment of the chemical composition in selected region(s) of interest. Currently, most clinical magnetic resonance (MR) scanners have routine sequences for proton MRS measurement, providing a range of metabolic and functional information integrated with complementary MRI localization; however, MRS requires additional acquisition time for post processing, and has difficulty in shimming due to air and intestinal movement [2].

Thus, identification of robust imaging biomarkers that can aid in preoperative staging and prognostication of endometrial cancer are highly warranted. Magnetic resonance imaging (MRI) has long been considered the preferred preoperative imaging method in endometrial cancer. Conventional pelvic MRI provides information on tumor size, myometrial invasion, cervical stroma invasion, and suspicion of pelvic lymph node metastases, together indicative of the tumor's aggressiveness. Novel functional MRI techniques have recently shown to be promising adjunct techniques in the preoperative assessment of endometrial carcinomas [6].

Dynamic contrast-enhanced (DCE)-MRI is a functional imaging technique enabling characterization of tumor microvasculature and angiogenic tumor profile in vivo. The calculated DCE-MRI parameters are, however, affected by the employed

acquisition technique as well as the choice of pharmacokinetic model [11].

A few recent studies of endometrial cancer patients, using different DCE-MRI models in patient series comprising 54-80 patients, have suggested a link between specific preoperative DCE-MRI parameters and an aggressive phenotype [12].

Diffusion-weighted imaging (DWI) measures the microscopic mobility of water molecules in the tissue. The diffusion properties are highly influenced by tissue microstructure, microcirculation, and cellular density. The reported diagnostic performance of DWI for preoperative staging in endometrial cancer is in the range of those reported for conventional contrast-enhanced MRI [13].

Diffusion-weighted and dynamic multiphase contrast medium-enhanced MR imaging sequences have been shown to improve the accuracy of MR imaging in assessing the depth of myometrial invasion and can be used to assess tumor response to therapy and to differentiate tumor recurrence from post treatment changes [14].

The main aim of this study was to evaluate the accuracy of DWI and dynamic contrast enhanced MRI in preoperative staging of endometrial carcinoma and prediction of severity of the disease prior to surgery.

This cross-sectional study was conducted, included 20 patients referred from the Gynecology Department to the Radiology Department in Ain Shams University hospitals from October 2020 to July 2021. They were all presented with postmenopausal bleeding or menorrhagia. The duration of the study ranged from 6-12 months.

The main results of this study were as following:

The mean age of the studied group was 58.45 ±11.49 years. 80% of them had age >50 years. However, in the study of Ali-Risasi et al. [15], the mean age for all participants was 43.0 years (±12.8 standard deviation (SD). In the study of Satta et al. [16], the mean age of their studied group was 72±10 years.

The present study showed that the majority (90%) 0f them had Endometrioid adenocarcinoma. 40% of them had Grade I adenocarcinoma (well differentiated). 35% had Grade II adenocarcinoma (moderately differentiated) and 25% had Grade III adenocarcinoma (undifferentiated). Our results were supported by study of Ryan et al. [17] which reported that there were 470 EC cases (94%) and 30 AH (atypical hyperplasia) (6%). Most EC were low grade (62%) and early-stage tumors (72%) of endometrioid subtype (70%).

Furthermore, Fasmer et al. [18] revealed that 78% of their studied group had endometrioid adenocarcinoma; 50% had grade I, 30% had grade II and 20% had grade III.

The current study showed that as regard MRI signal characteristics in the studied group; 45% were isointense in relation to myometrium on T2WI. 100% revealed high signal intensity (restricted diffusion) on DWI. 100% had ADC value $<1.2 \times 10^{-3}$ mm^2/s. There was no significant association between histological grade of endometrial carcinoma and the ADC value of each grade. There was highly significant difference between MRI Staging and Surgical Staging. There was no significant difference between MRI findings and Surgical Findings.

Our results were supported by study of Sala et al. [14] as they reported that the endometrial lesions appear of iso-intense signal relative to normal myometrial signals on T2WIs and of iso-intense signal relative to normal myometrium on T1WIs. This result also matches with findings done by Manfredi et al. [19] and Frei et al. [20].

Although MRI was not formally incorporated into the revised FIGO staging system for endometrial cancer, it is widely used to assess the stage of the disease and to plan the appropriate therapeutic approach. The standard MRI protocol includes high-resolution T2-weighted imaging (T2WI), in various planes, and multiphase dynamic contrast-enhanced (DCE)-MRI. However, there is no consensus regarding the best protocol, and recent studies have produced contradictory results, demonstrating no significant added value of DCE-MRI, either in the assessment of myometrial invasion or in the staging-nor have there been any reported differences between T2WI and DCE-MRI+T2WI in terms of interobserver agreement [22].

Simultaneously to the technical improvements and growing general interest in the use of diffusion-weighted imaging (DWI) in the evaluation of the female pelvis, studies have obtained encouraging results with the use of DWI in the preoperative assessment of endometrial cancer. However, further studies are needed in order to demonstrate its added value and to consolidate its use in clinical practice. DWI is a functional imaging technique that provides information about water mobility, tissue cellularity, and the integrity of cellular membranes. On DWI, endometrial cancer demonstrates restricted diffusion in comparison with that of normal myometrial

tissue, resulting in high signal intensity at high b-values (500-1000s/mm^2) and low apparent diffusion coefficient (ADC) values. ADC values are also significantly lower in endometrial cancer than in normal endometrium or in benign conditions such as endometrial polyps, leiomyomas, and endometrial hyperplasia **[23]**.

In the study of Kececi et al. **[24]**, fifty-six lesions classified as benign and malignant were compared in terms of ADC values. The mean ADC values were calculated for malignant lesions and benign lesions as 0.94±0.18 x 10^{-3} s/mm^2, and 1.45±0.22 x 10^{-3} s/mm^2, respectively. The mean ADC values of malignant lesions were lower than the mean ADC values of benign lesions, and this difference was statistically significant (p<0.05).

In the previous study, the depth of myometrial invasion was classified according to histopathological findings after surgery. Three of the 42 malignant lesions could not be included in the evaluation, which was performed to determine the depth of myometrial invasion due to the fact that contrast images could not be obtained. In 22 (56.4%) of the remaining 39 malignant lesions, tumors limited to the endometrial cavity, or myometrial invasion was less than 50% (IA). In the remaining 17 (43.6%) patients, myometrial invasion was equal to or more than 50% (IB). With reference of the histological results, for determination of the depth of myometrial invasion, the diagnostic accuracy of MRI was calculated separately for T2-DWI and DCET1W images. Diagnostic accuracy for T2-DWI for observer 1 and observer 2 were 87.1% (34/39) and 89.7% (35/39) respectively. No difference was observed between two observes with respect to T2-DWI evaluation (p>0.05). The accuracy rate for DCET 1 W images was similar for observer 1 and observer 2 and was 76.9% (30/39). For T2-DWI and DCET1W images, the agreement between observers in assessing the determination of the depth of myometrial invasion was excellent (kappa values 0.88 and 1.00, respectively) **[24]**.

Fujii et al. **[25]**, found that when the threshold ADC value which will be used to determine whether the lesions are malignant was accepted as 1.15 x 10^{-3} s/mm^2, the ADC value of 2 of 11 endometrial carcinomas were defined as grade 1 owing to histopathological results, over the threshold value. For this reason, they argued that the relatively high ADC values of low-grade tumors can constitute a diagnostic trap.

In the study conducted by Takeuchi et al. **[26]**, the mean ADC values for grade 1 and grades 2-3 were 0.84±0.17 x 10^{-3} s/mm^2, 0.71±0.17 x 10^{-3} s/mm^2, respectively. In this study, the mean ADC value of grade 1 tumors were higher than that of grade 2-3 tumors, but there was no statistically significant difference.

Furthermore, Bharwani et al. **[27]**, in their study, performed tests in order to evaluate the contribution of DWI on the diagnosis in determining tumor grades in the endometrial carcinomas, for each calculated mean ADC values for each histologic types as 1.02±0.29 x 10^{-3} s/mm^2 (grade 1), 0.88±0.39 x 10^{-3} s/mm^2 (grade 2) and 0.94±0.32 x 10^{-3} s/mm^2 (grade 3), respectively. Due to the fact that low-grade tumors include a lesser solid area than high-grade tumors, ADC values were expected to be higher. As a result of the study, due to the fact that there was a significant difference between grade of the tumor and mean ADC values, they emphasized that, in histological analysis, cellularity was not the only important factor for tumor grade, but that nuclear atypia was also an important factor, one which could not be evaluated by DWI for the purpose of determining the tumor grade. In our study, mean ADC values for each histological type of tumor were calculated as 0.91±0.16 x 10^{-3} s/mm^2 (grade 1), 1.00±0.21 x 10^{-3} s/mm^2 (grade 2), 0.87±0.13 x 10^{-3} s/mm^2 (grade 3). There was no difference between the mean ADC values in terms of tumor grade.

Diffusion-weighted imaging (DWI) is becoming a part of the standard imaging protocols for the assessment of the female pelvic region, in recent years. The image contrasts in DWI are a result of changes in the diffusion of water molecules in tissues. Malignant tumors are composed of tumor cells which are randomly organized and created an intense group. This effect prevents the free movement of water molecules, causing diffusion limitation. In the studies performed in recent years, it has been shown that the apparent diffusion coefficient (ADC) value in malignant lesions detected in the endometrial cavity were significantly lower than in benign lesions and normal tissue. In different studies, it has been reported that DWI can replace dynamic contrast-enhanced T1-weighted (DCET1 W) images in the assessment of myometrial invasion and can be used with T2W images in routine **[28]**.

In the study in our hands, as regard accuracy measures of (DWI-MRI/DCE MRI) in grading of Lymph node in relation to histopathology; its sensitivity and specificity were 100% & 93.3% respectively. As regard Accuracy measures of (DWI-MRI/DCE MRI) in assessment of Cervical

invasion in relation to histopathology; its sensitivity and specificity were 100% & 92.86% respectively. As regard accuracy measures of (DWI-MRI/DCE MRI) in assessment of deep myometrial invasion in relation to histopathology; its sensitivity and specificity were 92.86% & 100 % respectively.

Our results were supported by study of Kececi et al. **[24]** as they reported that the sensitivity, specificity and area under the curve for discriminating between malignant and benign lesions by using cutoff ADC value of 1.10×10^{-3} s/mm^2 were 85.7%, 92.8% and 0.95, respectively. According to the histopathological grading, there was no difference for the mean ADC values. For both observers the diagnostic accuracy of MRI in determining the depth of myometrial invasion in malignant lesions was found to be 87.1%, 89.7% and 76.9%, 76.9% for T2WI-DWI and DCET1WI, respectively.

In the study carried out by Lin et al. **[29]**, who reported that the diagnostic accuracy of diffusion-weighted MR imaging for assessing myometrial invasion ranges from 62% to 90%. In a prospective study by Rechichi et al. **[28]**, the staging accuracy of diffusion-weighted MR imaging was superior to that of dynamic contrast-enhanced MR imaging and had a higher level of inter-observer agreement. The authors suggested that diffusion-weighted MR imaging could replace dynamic contrast-enhanced MR imaging for endometrial cancer staging, offering the potential advantages of reduced scanning time and obviation of the intravenous administration of gadolinium-based contrast medium.

Furthermore, Thieme et al. **[30]** revealed that for detecting deep myometrial invasion, DWI achieved an accuracy, sensitivity and specificity of 94.3%, 92.3% and 95.5%, respectively, with PPV and NPV of 92.3% and 95.5%, respectively.which is matching with our results. DWI underestimated the depth of infiltration in one patient with deep myometrial infiltration and over-staged another patient with superficial myometrial infiltration at histopathology. Accuracy, sensitivity and specificity of DCE-MRI were 88.6%, 92.3% and 86.4% with PPV and NPV of 80.0% and 95.0%. DCE imaging overestimated the myometrial infiltration in three patients.

Conclusion:

DCE-MRI and DWI represent valuable supplements to conventional MRI by providing preoperative imaging biomarkers that predict aggressive disease in endometrial cancer patients.

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دور التصوير بالرنين المغناطيسى الموزون بمعامل الانتشار والرنين المغناطيسى بالصبغة فى التقييم قبل الجراحى لسرطان بطانة الرحم والتنبؤ بمدى شراسة المرض

\الخلفية: سرطان بطانة الرحم هو أكثر أنواع السرطانات النسائية شيوعاً بين النساء اليوم، وهو أكثر انتشاراً فى البلدان ذات المصادر العالية، ولكن حدوثه أخذ فى الارتفاع فى البلدان منخفضة الموارد نتيجة لزيادة السمنة وتحسين طول العمر.

\الهدف من \العمل: الغرض من هذه الدراسة هو تقييم دقة التصوير الموزون بالنتشار والتباين الديناميكى المعزز بالرنين المغناطيسى فى التدريج قبل الجراحة لسرطان بطانة الرحم والتنبؤ بشدة المرض قبل الجراحة.

\المرضى وطرق \الدراسة: اشتملت الدراسة على ٢٠ مريضاً تم تحويلهم من قسم أمراض النساء إلى قسم الأشعة بمستشفيات جامعة عين شمس. تعرضوا جميعاً لنزيف بعد انقطاع الطمث أو غزارة الطمث.

\النتائج: أظهرت الدراسة الحالية أنه فيما يتعلق بخصائص إشارة التصوير بالرنين المغناطيسى فى المجموعة المدروسة، كان ٤٥٪ متساوياً بالنسبة إلى عضل الرحم فى التصوير الموزون على شكل T2. كشف ١٠٠٪ عن شدة إشارة عالية (انتشار مقيد) على التصوير الموزون بالانتشار ١٠٠٪ كان لها قيمة معامل انتشار ظاهرة <١.٢ x ١٠-٣ mm^2/s. لم يكن هناك ارتباط معنوى بين الدرجة النسيجية لسرطان بطانة الرحم وقيمة معامل الانتشار الظاهر لكل درجة. كان هناك فرق كبير بين مراحل التصوير بالرنين المغناطيسى والتدريج الجراحى. لم يكن هناك فرق كبير بين نتائج التصوير بالرنين المغناطيسى والنتائج الجراحية.

\الخلاصة: التصوير بالرنين المغناطيسى المعزز بالتباين الديناميكى يمثل التصوير بالرنين المغناطيسى والتصوير الموزون بالانتشار مكملات قيمة للتصوير بالرنين المغناطيسى التقليدى من خلال توفير المؤشرات الحيوية للتصوير قبل الجراحة التى تتنبأ بمرض عدوائى فى مرضى سرطان بطانة الرحم.