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# Diffusion weighted imaging in suspicious uterine tumors; how efficient is it?

Nermeen N. Keriakos*, Eman Darwish

*Radiology Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt*

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ABSTRACT

*Background:* Uterine tumors are considered one of the major, causes of death. Detection, characterization and staging of these tumors, remain the cornerstone for proper management.

*Objective:* Describe the, various uterine tumors at DWI and assess its ability in, detection, characterization and staging of these tumors.

*Patients & methods:* This study included 25 patients with suspected endometrial and, cervical masses between June 2015 to December 2016.These were referred from, the ultrasound unit to the MRI unit of Radiology Department for further, characterization and staging of the tumors. All patients were evaluated, with transvaginal ultrasound and only those with suspicious masses were, included in our study. Conventional MRI with DWIs was done. All images were, analyzed as regards the degree of signal intensity and interpreted into a, quantitative measurement using the ADC mapping. This was followed by, staging of tumors using FIGO staging. The sensitivity, specificity and, diagnostic accuracy of DWI with the ADC cut off value in each malignancy, were calculated.

*Results:* DWIs with ADC maps showed a sensitivity and, specificity of 80% in endometrial cancers, sensitivity of 87.5% and, specificity of 100% in cervical cancers. The mean ADC value for, endometrial cancers was $0.8 \times 10^{-3}$ mm$^2$/s and $0.6 \times 10^{-3}$ mm$^2$/s for cervical, cancers.

*Conclusion:* Conventional MRI findings in conjunction with DWI and, quantitative measurement of the ADC are effective methods in the, diagnosis and staging of uterine cancer.

## 1. Introduction

Uterine malignancies are considered the most common gynecological cancers. 9% of newly diagnosed cancers are of uterine origin and account for 4.5% of causes of deaths in women. Endometrial and cervical carcinoma with uterine sarcomas are among the top list [1].

Endometrial carcinoma is common in elderly women and can be classified into type I and type II, with the former being hormone sensitive and accounts for more than 70% [2]. Leiomyosarcoma, endometrial stromal sarcoma, undifferentiated uterine sarcoma and carcinosarcoma are all types of uterine sarcomas and are derived from mesenchymal elements [3]. Cervical cancer is due to abnormal growth of the cells of the surface of cervix with invasion to surrounding tissues, being the second most common gynecologic malignancy. The incidence of invasive cervical cancer is higher in low-income countries due to lack of screening programs [4].

Conventional magnetic resonance imaging (MRI) is a high contrast resolution method. It is widely used in gynecologic imaging namely uterine and ovarian malignancies.

Later, diffusion-weighted imaging (DWI) has been added into routine protocols for pelvic MR imaging. This resulted in better characterization of lesions with better management of patients.

DWI gives functional information about movement of water from extra to intra cellular spaces, changes in membrane permeability and increased cellular density. These are the changes usually seen with tumors resulting in valuable addition of information to that derived from conventional MR images.

DWI plays a valuable role in assessment of residual and recurrent tumors. The apparent diffusion coefficient (ADC) is a quantitative measurement of DWI. And so using DWI with ADC can help evaluate tumor extension into the peritoneum, with quantitative follow up of those who are under therapy and hence the better monitoring of diagnosed patients under treatment [5]

Therefore, DWIs is useful to differentiate malignant from benign tumors. It can easily evaluate response to therapy and follow up of treatment. Hence it is proved to be a good adjunct to conventional MR imaging [6].

Moreover, DWI has added so much in assessment of female

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* Corresponding author at: 2 Saad Abdel Wareth Street, New Nozha, Cairo, Egypt.
*E-mail address:* nkeriakos@gmail.com (N.N. Keriakos).

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malignancies, where radiologists now can not only assess morphological but functional features of the tumors too. This greatly added to better characterization of lesions, more accurate staging of tumors with assessment of lymph node involvement and lastly the better follow up and monitoring of those under therapy.

*Aim of study:* To evaluate the efficacy of DWI in assessment of suspicious uterine tumors.

## 2. Patients and methods

### 2.1. Patients

This study was done in the period from June 2015 to December 2016. It included 25 patients with suspicious endometrial and cervical masses referred from the ultrasound unit to the MRI unit of Radiology Department for further evaluation. All patients who participated in this study were asked to sign a consent of agreement.

### 2.2. Methods

Transvaginal ultrasound was done to 50 cases using a high 8 MHz frequency transducer (GE Healthcare, Zipf, Austria) machine. 25 cases of them with positive ultrasound findings relevant to our inclusion criteria were only included in our study.

Our inclusion criteria were suspicious findings on transvaginal ultrasound: These were thick endometrium with heterogeneous texture ± myometrial invasion, bulky cervix/cervical masses ± increase vascularity on colour doppler. Exclusion criteria were patients known to have contraindications for MRI e.g. an implanted magnetic device, pacemakers and severe renal insufficiency with glomerular filtration rate < 30 ml/min and serum creatinine > 2.0 mg/dl as regards contrast injection.

The cases were then evaluated using a high resolution body coil on a 1.5T MR machine system (Achiva; Philips Medical Systems, Best, the Netherlands). All the patients were imaged in the supine position.

Sequences obtained were axial and sagittal fast spin-echo T1-weighted sequences, both with and without fat-suppression; axial, coronal, and sagittal T2-weighted sequences. Cuts were taken obliquely in orientation to the uterus. Parameters included: FOV 200–250 mm, slice thickness 4 mm, section gap 0.5–1 mm, matrix 192 × 256. DWI and ADC map were also done. The diffusion weighted imaging "DWI": Axial DWI with single shot echo planar imaging (EPI) performed at b values of 0 and 750 $mm^2/s$.

### 2.3. Image Analysis:

Conventional MRI images with DWIs were interpreted and analyzed by two different radiologists with full analysis of all sequences to assess the lesion regarding the size, shape, extensions and signal intensity in all sequences. DWIs were assessed regarding the degree of signal intensity and interpreted into a quantitative measurement using the Apparent Diffusion Coefficient (ADC) mapping. Lastly staging of endometrial and cervical cancers was done using FIGO 2009 staging as shown in Tables 1 and 2.

**Table 1**
FIGO 2009 staging of endometrial tumors.

| | |
|---|---|
| Stage IA | No or less than half of myometrial invasion<br>Endocervical glandular invasion is also stage IA |
| Stage IB | Invasion of half or more than half of myometrium |
| Stage II | Tumor invades cervical stroma but doesnot extend beyond the uterus |
| Stage IIIA | Tumor invades uterine serosa and/or adnexa |
| Stage IIIB | Vagina and parametrial spread |
| Stage IIIC | Metastasis to pelvic and para-aortic nodes |
| Stage IVA | Invasion of bladder and/or rectal mucosa |
| Stage IVB | Distant metastasis and/or inguinal node involvement |

**Table 2**
FIGO 2009 staging of cervical tumors.

| Stage | Extent of disease |
|---|---|
| 0 | Carcinoma in situ (CIN) |
| I | Limited to cervix |
| Ia1 | Microscopic disease:<br>Stromal invasion < 3 mm, lateral spread < 7 mm |
| Ia2 | Microscopic disease:<br>Stromal invasion > 3 mm and < 5 mm, lateral spread < 7 mm |
| Ib1 | Macroscopic lesion < 4 cm in greatest dimension |
| Ib2 | Macroscopic lesion > 4 cm in greatest dimension |
| II | Extension to uterus/parametria/vagina |
| IIa1 | Involvement of upper two thirds of vagina without parametrial invasion, < 4cm greatest dimension |
| IIa2 | Involvement of upper two thirds of vagina without parametrial invasion, > 4cm greatest dimension |
| IIb1 | Involvement of upper two thirds of vagina with parametrial invasion |
| III | Extension to pelvic side wall and/or lower third of vagina |
| IIIa | Involvement of lower third of vagina |
| IIIb | Extension to pelvic side wall and/or hydronephrosis |
| IV | Extension to adjacent organs or beyond true pelvis |
| IVa | Extension to adjacent organs e.g. bladder, bowel |
| IVb | Distant metastasis |

Images were diagnosed as malignant when one or more of the following was found:

1. low/heterogenous signal lesion seen within the hyperintense normal endometrium ± myometrial invasion.
2. Bulky cervix ± irregular mass of higher signal than normal cervical tissue on T2 images.
3. On DWI: lesion showing restricted diffusion; i.e giving high signal on DWI and low signal on (ADC) maps.
4. This was followed by quantitative analysis of the tumors on the ADC maps by careful drawing of the ROI's in order to include the largest possible area of the lesion putting into consideration exclusion of cystic areas.

### 2.4. Statistical analysis

Statistical analysis was done using MedCelc© version 12.5 (MedCalc© Software bvba, Ostend, Belgium) and DAG stat (Mackinnon, 2000). Suspicious tumors identified at transvaginal ultrasound proceeded to MRI study with DWI and ADC mapping. The finding were analyzed in both endometrial and cervical tumors. Sensitivity, specificity, positive and negative predictive values and accuracy rates of DWI were then calculated in both endometrial and cervical tumors.

## 3. Results

This study included 25 patients with suspicious uterine lesions; 15 endometrial and 10 cervical. The patients age ranged from 42 to 65 years with mean age 52 years.

### 3.1. Analysis of data in endometrial tumours

We had 15 endometrial lesions, seven cases showed low signal intensity in T2 while 3 cases showed heterogeneous signal intensity due to cystic degeneration (Fig. 5) and five cases showed hyperintense signal as part of benign normal endometrial hyperplasia. Other imaging features are shown in Table 3.

By DWIs and ADC map, 9 cases out of the 15 endometrial lesions showed restricted diffusion with corresponding low ADC signal, and hence were diagnosed as malignant. 6 cases were diagnosed as benign as they showed facilitated diffusion with high corresponding ADC signal. Histopathology showed 10 malignant endometrial lesions and 5