Role of diffusion-weighted magnetic resonance imaging in the characterization of uterine neoplasms

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Context
Uterine malignant neoplasms are considered a frequent major cause of mortality.
Aims
To detect the role of diffusion-weighted images in assessing uterine neoplasms.
Settings and design
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Patients and methods
Our study included 20 patients with uterine neoplasms. All patients were examined by pelvic advanced MRI techniques with diffusion MRI.
Statistical analysis
Categorical data were reported in frequencies and percentages. Quantitative data were reported as mean (SD) and evaluated for statistically significant differences between both groups utilizing independent Student's *t* test.
Results
The apparent diffusion coefficient value in benign uterine lesions is equal to 1.088 ± 0.146 and for the malignant lesions it is equal to 0.658 ± 0.178 with a *P* value of 0.000 which is highly significant. A cutoff apparent diffusion coefficient value of 0.85 × 10^{-3} mm^2/s for malignant lesions resulted in 91.7% sensitivity, 100% specificity, 100% positive predictive value, 88.7% negative predictive value, and 91.67% accuracy.
Conclusions
Diffusion-weighted image has a great role in differentiating malignant and benign uterine neoplasms.

Keywords:
Uterine mass, endometrial carcinoma, cervical carcinoma, MRI, diffusion

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Introduction

Neoplasms of the female genital tract are the second most frequent cancer among the female population after breast cancer [1]. MRI plays an evolving role in gynecological neoplasms. Currently, diffusion-weighted image (DWI) is considered an vital part of the MRI study of the female pelvis, providing functional data compared with conventional MRI sequences that provide anatomical information [2]. DWI provides both qualitative and quantitative data that help in tumor assessment [3]. Quantitative measurement of the apparent diffusion coefficient (ADC) value gives objective information helping in distinguishing malignant and benign uterine lesions [4].

Patients and methods

Study population

This study included 20 patients with uterine neoplasms who were admitted to the Gynecology Department at Assiut University Hospitals from January 2016 to December 2017. The study was approved and monitored by the Medical Ethics Committee, Assiut Faculty of Medicine, IRB 17100955. Patients signed an informed consent. The diagnosis of uterine neoplasms was determined by pelvic MRI and DWI and was then compared with histopathological findings.

Imaging technique

MR studies were conducted using a 1.5-T MRI machine (Achieva; Philips Medical System, The Netherlands). A phased-array surface coil was used to improve the signal-to-noise ratio. All the cases were examined in supine position by using the phased-array surface coil throughout the following sequences: axial T1WI, sagittal T2WI, axial T2WI, coronal

T2WI, and axial DWI. DWI was done using the diffusion sensitizing gradient which was applied in three orthogonal directions and ADC maps will be automatically reconstructed for all DWIs.

Data processing and analysis

MRI were blindly evaluated without knowing the pathologic results or lesion location. Imaging variables were assessed for each tumor included the following: maximum diameter, location, tumor extension, signal intensity, and homogeneity. The tumor signal intensity was evaluated subjectively on T1 and T2 as hyperintense, hypointense, and isointense when compared with the skeletal muscle. Visual inspection of DW-MRI (with *b* values 0, 50, 400, 800, and 1000) and coregistered anatomical images had been undertaken together. Quantitative measurements of DWI were generated by tracing maps of ADC and using a commercially available extended work space workstation.

Statistical analysis

Continuous data were reported as mean ± SD if normally distributed. Categorical data were reported in frequencies and percentages and analyzed with Fisher's exact test. Quantitative data for all patients were evaluated for statistically significant differences between both groups utilizing a two-tailed, independent Student's *t* test if data were normally distributed. Statistical significance was accepted at *P* value less than 0.05. Receiver operating characteristic curve analysis was used to detect cutoff values, sensitivity, specificity, positive, and negative predictive values, and accuracy. In statistical analysis, SPSS (version 23, SPSS for windows; SPSS inc., Chicago, IL, USA) was used.

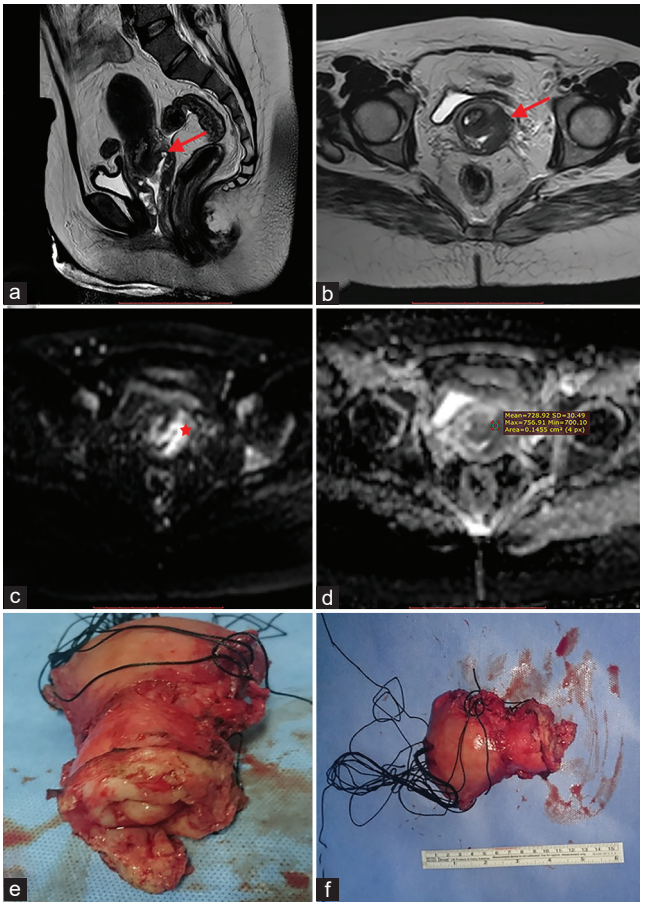
Results

A total of 20 female patients, aged 24–85 years (mean, 56 years) presented with uterine masses were included in the statistical analysis. There were 14 (70%) uterine corpus tumors and six (30%) cervical tumors. Of these tumors, 12 (60%) were malignant (seven uterine corpora and five uterine cervices) and eight (40%) were benign (seven uterine corpora and one uterine cervix). We found that there was no significant correlation between the age and the nature of the uterine tumor according to the independent *t* test with *P* value = 0.612.

As regards tumor characteristics using conventional MRI, no statistical difference in the T1 signal was present between malignant and benign uterine tumors (P = 0.055). There was highly significant statistical difference in T2 signal between the groups (P = 0.001). The ill-defined lesion margin was strongly related to malignant nature (P = 0.000). Tumor size showed no significant difference (P = 0.966).

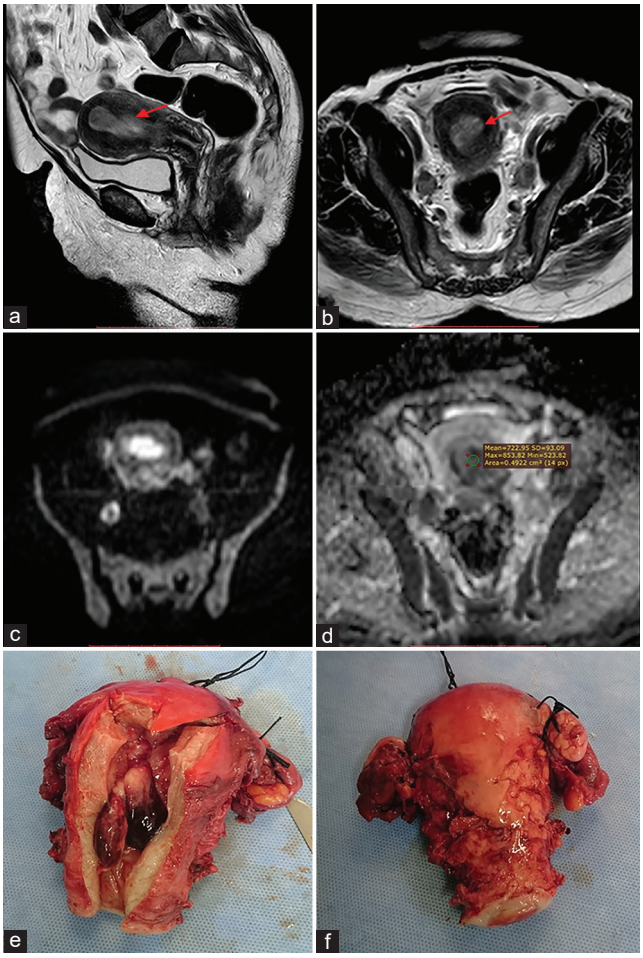
On DWI, malignant lesions clearly exhibited increased signal intensity (restricted diffusion), while benign lesions showed free diffusion (Figs. 1–3). There is a significant correlation between diffusion restriction and the nature of the uterine tumor (P = 0.000). The mean ADC values in benign uterine lesions was $1.075 \pm 0.158 \times 10^{-3}$ mm^2/s and for malignant lesions, it was $0.658 \pm 0.178 \times 10^{-3}$ mm^2/s, P value = 0.000. Receiver operating characteristic analysis showed that a cutoff ADC value less than or equal to 0.8×10^{-3} mm^2/s for malignant lesions resulted in 91.7% sensitivity, 100% specificity, 100% positive predictive value, 88.7% negative predictive value, and 91.67% accuracy (Fig. 4).

Figure 1



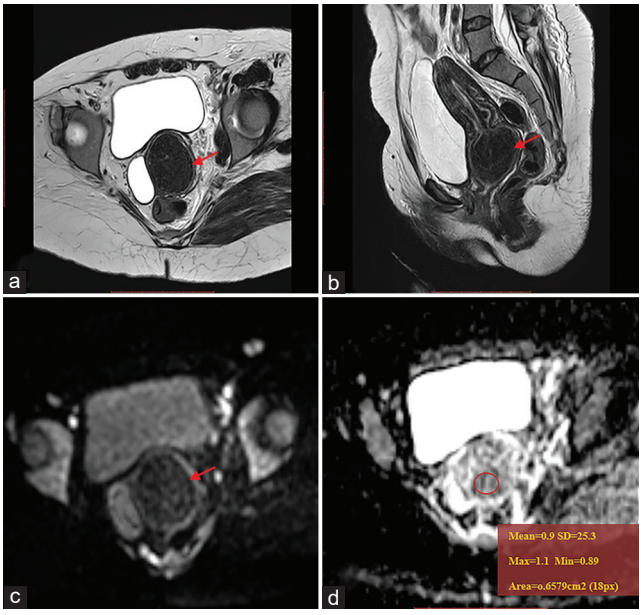
A 33-year-old female patient of presented with lower abdominal pain of 2 months duration and clinically palpable cervical mass involving the upper third of the vagina. Conventional MRI study (a and b) shows an ill-defined exophytic cervical mass (arrows) arising from the posterior lip of the cervix with the invasion of the upper third of the vagina and parametrium, isointense in TIWI, and hyperintense in T2WI. In DWI (c), the tumor has restricted diffusion * with a low signal on ADC map (d). Radical hysterectomy was done (e and f). Histopathological examination showed well-differentiated adenocarcinoma. ADC, apparent diffusion coefficient; DWI, diffusion-weighted image.

Figure 2



A 70-years-old female patient presented with postmenopausal bleeding. Conventional MRI study (a and b) showed a bulky uterus with endometrial thickening forming a mass lesion, (arrow) hyperintense in T2WI with disruption of the junctional zone. There are multiple enlarged lymph nodes (asterisks). In DWI (c), the tumor has restricted diffusion with low signal on the corresponding ADC map (d). Radical hysterectomy was done (e and f). Histopathological examination showed endometrial adenocarcinoma endometrioid type grade II. ADC, apparent diffusion coefficient; DWI, diffusion-weighted image.

Figure 3



A 36-year-old female patient presented with lower abdominal back pain of 4 months duration, cervical discharge, and clinically palpable cervical mass. Conventional MRI study (a and b) showed a well-defined near round cervical mass (arrows) measuring about 4.5 × 4.2 × 5 cm exhibiting isointense signal in TIWI and hypointense signal in T2WI. In DWI (c), the tumor has free diffusion with an ADC value (d) of 0.9 × 10^{-3} mm^2/s. Hysterectomy was done. Histopathological examination showed cervical leiomyoma. ADC, apparent diffusion coefficient; DWI, diffusion-weighted image.

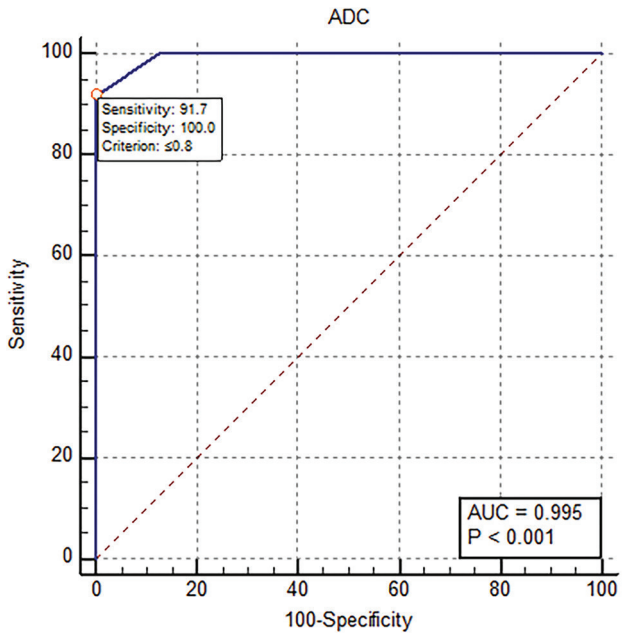
Discussion

In this study, we had performed an analysis of the conventional MR sequences and DWI regarding their performance in the evaluation of uterine neoplasms. We compared the two groups as regards conventional MRI findings including T1WI and T2WI as well as diffusion and ADC maps. As regards the T1 signal, no statistical difference was found, while the T2 signal showed a statistical difference between the groups where malignant tumors mainly exhibit a T2 high signal.

In this study, all malignant tumors (12 cases) showed restricted diffusion, while the benign tumors showed free diffusion. The mean ADC values for malignant tumors were lower than for benign tumors. The study by Tamai *et al.* [5] supports our results as they found the ADC value (×10^{-3} mm^2/s) of endometrial cancer to be 0.88 ± 0.16. They concluded that DWI is reasonable in determining endometrial cancer. Another study carried out by Takeuchi *et al.* [6] concluded that the ADC values in malignant and benign lesions were 0.849 and 1.589 × 10^{-3} mm^2/s, respectively. Also, our results were in concordance with a study carried out by Masroor *et al.* [7] on 52 patients. Their ADC value for endometrial cancer was much lower than normal endometrium ($P < 0.001$).

In this study, the optimal cutoff of ADC was 0.8 × 10^{-3} mm^2/s below which malignant uterine lesions are suspected. In the study carried out by Takeuchi *et al.* [6], their cutoff ADC value (1.2 × 10^{-3} mm^2/s) was higher than that of our study. A nearly similar cut off value was stated by Atstupėnaitė *et al.* [8], who defined an ADC threshold of 0.945 × 10^{-3} mm^2/s that can differentiate the cancer-affected cervical tissue from the normal. Nearly similar results were obtained by Takeuchi *et al.* [6], on using their cutoff value for detecting malignant lesions and they obtained near sensitivity and specificity. In another study carried out by Bharwani *et al.* [9] who found that a cutoff less than or equal to 1.28 had 87% sensitivity, 100% specificity, 100% positive predictive value, and 85.7% negative predictive value for malignancy.

Figure 4



Receiver operating characteristic curve analysis showing the diagnostic performance of ADC in differentiating malignant from benign uterine tumors. ADC, apparent diffusion coefficient.

Conclusion

DWI has a crucial role in differentiating benign and malignant uterine tumors.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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