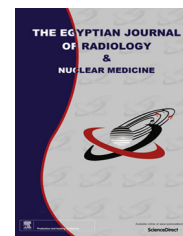




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ORIGINAL ARTICLE

MR diffusion imaging in preoperative evaluation of depth of myometrial invasion in endometrial carcinoma



Magda S. Shady, Magda A. Bakry, Jehan A. Mazroa, Basma N. Gadelhak *

The Department of Radiodiagnosis, Faculty of Medicine, Mansoura University, Egypt

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KEYWORDS

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Abstract *Objective:* To investigate the accuracy of high b value Diffusion Weighted Imaging (DWI) combined with T2-WI in estimating the depth of myometrial invasion in endometrial carcinoma compared to the accuracy of post contrast MRI.

Subjects and methods: Twenty-seven patients with histologically proven endometrial carcinoma were enrolled in this study. T2-weighted, post contrast T1-weighted after 30, 60, 120 s, and DWI with b values of 0, 500 and 1000 s/mm² were obtained. The Depth of myometrial invasion was assessed. The ADC values were measured and correlated with the depth of myometrial invasion and with the histological grade.

Results: The high b value DWI showed similar sensitivity and higher specificity in evaluating the depth of myometrial invasion compared to the post contrast MRI. No correlation was found between the ADC values and the depth of myometrial invasion. No correlation was found between the ADC values and the histologic tumor grade.

Conclusion: DW-MRI has a high diagnostic efficacy comparable to that of post contrast study, making it a good alternative in preoperative evaluation of depth of myometrial invasion in endometrial carcinoma patients. DW-MRI thus should be considered part of the routine pre-operative pelvic MRI in this group of patients.

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1. Introduction

DW sequences measure the random motion of water in tissues, and malignant tumors have higher cellularity than

benign lesions and are associated with restriction to water diffusion (1).

Endometrial carcinoma shows restricted diffusion compared to normal endometrium resulting in hyperintensity on high b values DWI and corresponding hypointensity on ADC maps (2).

There are different factors that affect the prognosis of endometrial carcinoma such as Histologic grading, depth of myometrial invasion and lymph nodes metastasis (3). The most

* Corresponding author.

E-mail address: basmagadelhak@hotmail.com (B.N. Gadelhak).

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important single prognostic feature is depth of myometrial invasion with 50% myometrial invasion cutoff dividing the FIGO stage I into Ia and Ib (4). Deep myometrial invasion is associated with increases in risk of pelvic lymph node involvement and parametric extension (3).

At present, MR examination including T2 WI and DCE imaging is considered the standard for preoperative staging of endometrial cancer and for detection of depth myometrial invasion in patients with endometrial cancer (4).

Diffusion-weighted imaging (DWI) is frequently used in association with T2 and DCE MR imaging although it is not yet included in current imaging guidelines updated by 2011 (5).

The raised concerns about the use of gadolinium contrast in patients with impaired renal function were a reason to investigate the role of DW imaging in evaluating the depth of myometrial invasion (6).

The purpose of this work was to study the diagnostic accuracy of T2WI with DW magnetic resonance imaging in the pre-operative detection of depth of myometrial invasion in patients with endometrial cancer, to compare the ADC values in superficial and deep myometrial invasion and to compare the ADC values in different histologic grades of endometrial carcinoma. The surgical-pathologic staging was the reference.

2. Subjects and methods

2.1. Study population

This prospective study, performed at MRI unit in radiology department –University Hospital – during the period of April 2013 and March 2015, included 27 patients with endometrial carcinoma that had been confirmed pathologically. All patients underwent subsequent total hysterectomy.

The mean patient age was 61 years (range: 48–81 years).

The exclusion criteria for this study were patients who did not undergo surgery, patients who received preoperative chemotherapy or radiotherapy, patients with MR incompatible devices (pacemaker, aneurysm clips, pelvic metal prostheses), and claustrophobic patients.

Informed consents were obtained from all participants. Ethical Board Institute approved the study.

2.2. MRI protocol

All MRI examinations were performed on a 1.5-Tesla scanner (Philips-Enigma, the Netherlands) with a phased-array pelvic coil.

The MRI protocol consisted of the following:

- T1-weighted images acquired in the axial plane with the following parameters: TE 4.6 ms; TR 4.4 ms; slice thickness 7 mm; inter-slice gap 1 mm; FOV 36 × 40 cm; matrix 256 × 320; number of slices 25.
- T2-weighted turbo spin-echo images acquired in the sagittal and oblique axial planes parallel to the long and short axis of the uterus with the following parameters: TE 85 ms; TR 5000 ms; slice thickness 3 mm; inter-slice gap 0.3 mm; FOV 18 × 12 cm; matrix 361 × 198; number of slices 32.
- DW images with echo-planar technique after fat suppression obtained in the axial plane with the following parameters : TE 80 ms; TR 2640 ms; slice thickness 5 mm;

inter-slice gap 1.5 mm; FOV 40 × 28 cm; matrix 160 × 87; number of slices 60; *b* factor 0, 500 and 1000 s/mm²; number of signals averaged 10. Patients were breathing freely. Image fusion was not used.

- Gadolinium – enhanced T1-weighted images after fat suppression obtained in the axial plane after injection of gadopentetate dimeglumine (Magnevist) at a dose of 0.1 mL/kg body weight with the following parameters: TE 2.1 ms; TR 4.3 ms; slice thickness 2 mm; FOV 40 × 28 cm; matrix: 256 × 196; number of slices 50. The injection flow rate was 2 mL/s, and the contrast injection was followed by a 20-mL saline flush. Images were acquired after 0, 30, 60, and 120 s of contrast injection.

2.3. MR image analysis

The T2WI and post contrast MRI images were first reviewed followed by Evaluation of T2WI and DWI by Two expert radiologists of 27 and 18 year experience blinded to final histopathologic diagnosis.

For analysis of the T2-weighted images and dynamic T1-weighted images, the criteria for endometrial cancer diagnosis were the high or heterogeneous signal intensity on T2WI and the mild enhancement on the delayed post contrast images against the more intensely enhancing myometrium.

On high *b* value DW images (*b* value of 1000 s/mm²), endometrial cancer was diagnosed when a bright-signal-intensity area is seen contrasting against the dark background. The corresponding ADC map showed low signal intensity and low ADC values. All DW images were evaluated in reference to corresponding ADC maps to avoid T2 shine-through effect.

ADC maps were generated on the scanner console on a pixel-by-pixel basis from the DW images.

All ADC measurements were obtained on ADC maps that contained the largest tumor so that the largest region of interest (ROI) could be drawn within the targeted tissues (see Figs. 1–4).

One circular ROI was placed in the center of the tumor. Necrotic areas were excluded based on findings on T2-weighted MR images.

For each case, the part of myometrial wall with deepest tumor invasion was localized and the extension of tumor into the myometrium was estimated. The depth of myometrial invasion was then classified into superficial (no myometrial invasion or invasion to less than one half of myometrial thickness) or deep (invasion to one half or more of the myometrial thickness) on both Post contrast MR Images and on DW Images. Then ADC values of each group were compared.

2.4. Surgical procedure and histopathological analysis

All the study groups underwent total hysterectomy 4–10 days after MR imaging (average, 6 days).

The surgical procedures were performed in the Gynecology Department – University Hospital.

The surgical specimens were evaluated by experienced pathologists stressing upon the histologic type (Table 1). Tumor grades were determined (G1, well-differentiated; G2, moderately differentiated; G3, poorly differentiated) (Table 2). For each case, maximum depth of myometrial invasion was estimated and localized.

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