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The utility of diffusion-weighted magnetic resonance imaging in differentiation of endometriomas from hemorrhagic ovarian cysts

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ABSTRACT

The aim was to determine the utility of diffusion-weighted magnetic resonance imaging (DW MRI) and apparent diffusion coefficient (ADC) measurements in differentiation of endometrioma and hemorrhagic ovarian cyst. A total of 24 female patients who underwent pelvic MRI with an initial diagnosis of ovarian cyst were included in the study. The final diagnosis was endometrioma in 12 patients and hemorrhagic ovarian cyst in 12 patients. We observed significantly lower ADC values in endometriomas compared with hemorrhagic ovarian cysts in all *b* values. DW MRI with quantitative ADC measurements can be used for differentiation of endometrioma from hemorrhagic ovarian cysts.

1. Introduction

Adnexa are anatomic regions between pelvic walls and uterine cornus. A mass in this region generally originates from ovaries, and many of them can mimic each other with similar imaging findings. Differentiation of endometrioma from hemorrhagic ovarian cyst can be challenging among ovarian pathologies. Endometriosis may contribute to pelvic pain and infertility. It was shown that patients with endometriosis have an increased risk of developing clear cell and endometrioid epithelial ovarian cancer [1]. Therefore, it becomes important to differentiate endometrioma that have coexistence with endometriosis from hemorrhagic ovarian cyst that spontaneously resolves with no associated malignancy risk.

The role of magnetic resonance imaging (MRI) in evaluation of pelvic gynecologic pathologies increased in recent years [2]. Despite the usefulness of ultrasonography in characterization of adnexal masses, MRI is a superior imaging method with an accuracy rate over 90%, and it is generally used as a problem solver [2]. It was reported that MRI limits additional expense and invasive diagnostic and surgical applications and has advantages in terms of cost-effectiveness contrary to general belief [3].

Diffusion-weighted (DW) MRI is a new technique that shows the molecular diffusion difference which is also known as Brownian motion. On DW MRI, image contrast is affected by Brownian motion of water molecules and gives information about microscopic level [4–6]. DW MRI also gives quantitative biophysical parameter of the water called apparent diffusion coefficient (ADC) [7,8]. By the way, DW imaging gives both qualitative and quantitative information that can be useful in differentiation of different lesions from each other. This is also an advantageous method which can be performed in a single breath hold period and without contrast administration. This technique was first described for early diagnosis of acute ischemic stroke in neuroradiology [9]. The usage of DW MRI in abdominal organs was also improved in conjuction with the development of fast MRI sequences such as echo-planar imaging.

In the present study, we aimed to determine the utility of DW MRI and ADC measurements in differentiation of endometrioma from hemorrhagic ovarian cyst.

2. Material and methods

A total of 24 female patients who were referred to our department for pelvic MRI with a suspected gynecologic mass between October 2007 and October 2008 were included in this study. All patients gave written informed consent for MRI examination. This study was approved by our institutional review board. From the study patients, 6 were operated and 18 were followed up. According to the histopathologic evaluation and

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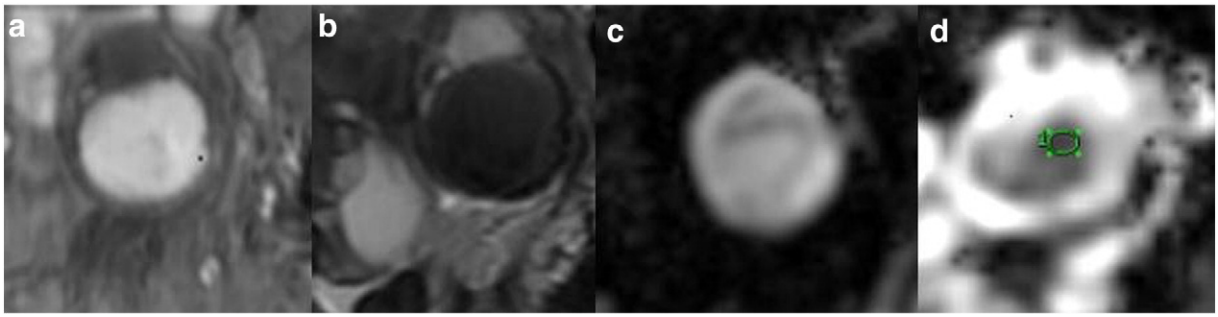

Fig. 1. A histopathologically proven endometrioma with heterogenous appearence in left ovary is seen. It is hyperintense on fat-saturated T1W image (a) and hypointense on T2W image (b). DW MR image demonstrates hyperintense appearance in the cyst (c). ADC was measured as 1.5×10^{-3} mm^2/s with *b* 600 (d).

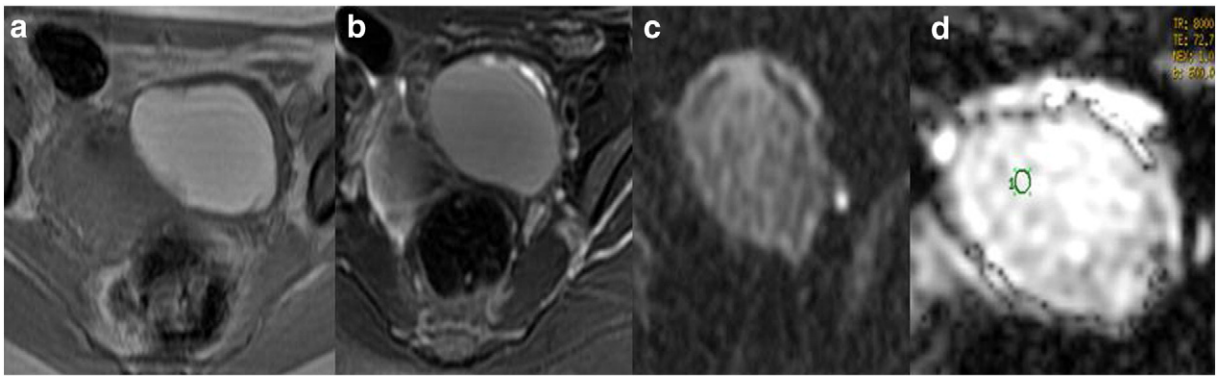

Fig. 2. A hemorrhagic ovarian cyst in the left ovary is seen. The lesion is hyperintense on T1W (a), T2W (b), and DW MR (c) images. ADC was measured as 1.74×10^{-3} mm^2/s with *b* 600 (d).

follow-up results, the final diagnosis was endometrioma for 12 lesions and hemorrhagic ovarian cyst for 12 lesions.

2.1. MR examination

All patients underwent pelvic MRI with a 1.5-T MR unit (Signa Hispeed Excite; General Electric, Milwaukee, WI, USA). The patients were examined in supine position. Diffusion-weighted MR images were obtained by a four-channel phased-array coil for body using an echo planar imaging in the axial plane without breath holding in approximately 30 s. A three-plane gradient echo localizer sequence was performed at the beginning of the examination. Imaging parameters were repetition time (TR)/echo time (TE): 8000/80 ms; section thickness: 5 mm; intersection gap: 0; matrix size: 128×128; field of view: 300×300 mm; and water excitations with *b* values of 100, 600, and 1000 s/mm^2 for DWI. Axial T2-weighted spin-echo sequences (TR/TE=4100/95, section thickness: 5 mm, intersection gap: 1 mm) were also performed for lesion detection. T2-weighted images were used for detection of lesion and lesion diameters. Color-coded ADC maps were automatically created by the diffusion difference between gradients *b* 100, *b* 600, and *b* 1000 s/mm^2 and the *b* 0 gradient on a workstation (Advantage Windows, software version 2.0; General Electric Medical Systems). Monoexponential method was used in ADC measurements. A minimum mean square error estimator was used in the monoexponential method to minimize the mean square error of the fitted ADC values. The mean ADC values were calculated on images with all acquired *b* values. A round or elliptical region of interest (ROI) with an area range between 50 and 70 mm^2 was placed by a radiologist (M.B., with 4 years of experience) on color-coded ADC maps of the detected lesions. The ROIs were placed in the center of pure cystic lesions or solid-like component of complex cystic lesions.

Calculated ADC values for *b* values of 100, 600, and 1000 s/mm^2 were compared for groups.

2.2. Statistical analyses

Data were summarized as mean±standard deviation for continuous variables and frequencies for categorical variables. Mann–Whitney *U* test was used for independent group comparisons depending on the distributional properties of the data. A *P* value <.05 was considered as statistically significant. In order to determine the diagnostic accuracy of ADC measurements, receiver operating characteristic (ROC) analysis was performed. Cutoff ranges were calculated around the optimal cutoff to maximize sensitivity and specificity for discrimination of endometrioma from hemorrhagic ovarian cyst. Youden index *J* values were used to compare diagnostic accuracy of ADC measurements in different *b* values.

3. Results

A total of 24 female patients with ovarian lesions were included in this study. The final diagnosis was made according to the histopathologic evaluation ($n=6$) or follow-up results ($n=18$), which are based on follow-up ultrasound examinations. The diagnosis of five patients was endometrioma and one patient was hemorrhagic ovarian cyst according to the histopathologic evaluation. Other patients with endometrioma were treated with drugs. Lesions were divided into two groups: endometriomas ($n=12$) and hemorrhagic ovarian cysts ($n=12$). At the time of the imaging, the mean age of the patients was 33.4 years±10.8 (standard deviation; range, 18–58 years). The mean age of the patients with endometrioma was 37 years±12.8 (standard deviation; range, 22–58 years), and that of patients with hemorrhagic ovarian cysts was 30.1 years±7.3 (standard deviation; range, 18–40 years). The mean size of all lesions was 4.9 cm±2.1 (standard deviation; range, 2.5–11 cm), that of endometriomas was 4.5 cm±1.4 (standard deviation; range, 3–7.5 cm), and that of hemorrhagic ovarian cysts was 5.3 cm±2.7 (standard deviation; range, 2.5–11 cm). There was no difference observed in terms of patient age ($P=.247$) and size of the lesions ($P=.560$) between the two groups.