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The utility of diffusion-weighted MR imaging in differentiation of uterine adenomyosis and leiomyoma

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ABSTRACT

Purpose: To investigate the value of diffusion-weighted MR imaging (DWI), especially apparent diffusion coefficient (ADC) in the differentiation of uterine adenomyosis and leiomyoma.
Materials and methods: 17 patients with uterine leiomyoma and 22 patients with uterine adenomyosis underwent diffusion-weighted imaging (DWI) in addition to routine MR imaging. The ADC values, as well as ADC *D*-value (defined as the ADC value of high signal intensive foci minus the ADC value of lesion tissues the difference in value), were measured and compared to investigate whether they could help in the differentiation of uterine adenomyosis and leiomyoma. Histopathologic examination was conducted as the golden standard.
Results: For high signal intensive foci within the lesions, uterine adenomyosis demonstrated significantly lower mean ADC value than uterine leiomyoma (1.582 vs. 2.122×10^{-3} mm^2/s, $P = 0.001$). For lesion tissues, uterine adenomyosis demonstrated significantly higher mean ADC value than uterine leiomyoma (1.214 vs. 0.967×10^{-3} mm^2/s, $P = 0.001$). However, there was overlap between uterine adenomyosis and leiomyoma in both measurements. Mean ADC *D*-value was significantly lower in uterine adenomyosis than in uterine leiomyoma (0.369 vs. 1.096×10^{-3} mm^2/s, $P = 0.000$). ADC *D*-value had no overlap between uterine adenomyosis and leiomyoma.
Conclusion: DWI can be applied for the further differentiation of uterine adenomyosis and leiomyoma, in addition to routine MR imaging. ADC *D*-value may be a more useful tool than ADC value in the differentiation.

1. Introduction

Adenomyosis is a common gynecologic condition that affects menstruating women, diagnosis based on clinical findings is usually difficult because of the nonspecific nature of the symptoms. Leiomyoma is by far the most common uterine tumor, and it shows clinical presentations similar to those of adenomyosis. The advancement of non-invasive diagnostic techniques, such as transvaginal ultrasound (TVS) and magnetic resonance (MR) imaging improves the differentiation accuracy of adenomyosis and leiomyoma in most instances [1,2]. However, TVS may occasionally have limitations in accurately differentiating between leiomyomas and adenomyosis [3]. On MR images, in contrast to a poorly defined margin in adenomyosis, leiomyoma typically exhibits a well-circumscribed mass with a 'pushing' border between it and the surrounding myometrium [4]. Although typical MR features of adenomyosis are well documented, MR features of adenomyosis and leiomyomas can be variable because of the variety of morphological patterns.

Diffusion-weighted imaging (DWI) is a recently developed technique used to show tissue characteristics based on the diffusion motion of water molecules. Because of the severe motion sensitivity of DWI, the problems of respiratory and cardiac motion, arterial pulsation, bowel peristalsis, and susceptibility effects have been obstacles to the application of DWI to abdominal and pelvic imaging. DWI can also provide the quantitative measurement of apparent diffusion coefficient (ADC) values, which are considered to be influenced by the nuclear-to-cytoplasm ratio and cellular density in solid tissues. DWI now plays an important role in the diagnosis of brain disorders, it has not been fully applied in body imaging as the image quality suffers from blurring because of the long readout interval and from artefacts caused by high susceptibility to resonance offsets. Recent advances in MR technology such as higher magnetic field strengths, parallel imaging techniques and phased-array receiver coils have finally made the acquisition of

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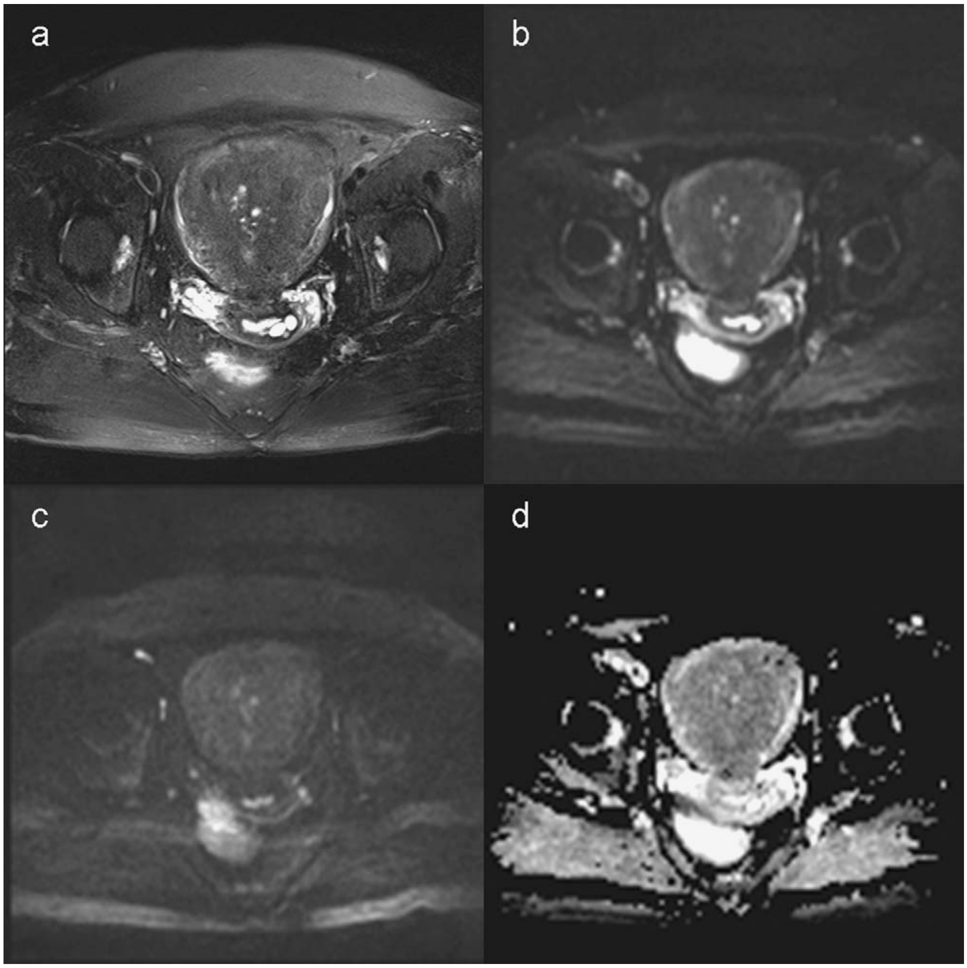

Fig. 1. A 43-year-old woman with adenomyosis. (a) Axial T2-weighted image shows a lesion of low intensity with high signal intensive foci in it. (b) DWI on $b = 0$ shows an area of homogeneous hypointensity with high signal intensive foci in it. (c) DWI on $b = 1000$ visualises an area of isointensity with hyperintensity foci in it. (d) ADC map demonstrates an area of hypointensity with hyperintensity foci in it. The ADC values of high signal intensive foci and lesion tissues within adenomyosis were 1.690×10^{-3} mm^2/s and 1.280×10^{-3} mm^2/s, respectively. T2 shine-through effect refers to high signal intensity on low *b*-value, high *b*-values and ADC maps.

DWI in the body feasible for clinical use by decreasing the distortion and imaging time. There is an increasing use of DWI in abdominal and pelvic organs, reports show that DWI can be successfully applied to the imaging of the uterus [5–14]. There were few preliminary reports in the literature regarding the usefulness of DWI in the differentiation of uterine adenomyosis and leiomyoma.

The purpose of this study was to investigate the value of DWI, especially ADC in the differentiation of uterine adenomyosis and leiomyoma.

2. Materials and methods

2.1. Patients

According to the institutional review board, the requirement for informed patient consent in this retrospective study was waived. We retrospectively reviewed the diffusion-weighted MR imaging (DWI) of uterine leiomyoma and uterine adenomyosis from December 2009 to January 2011, in addition to routine MR imaging. The inclusion criteria were: histopathologic confirmed uterine leiomyoma or uterine adenomyosis; underwent diffusion-weighted imaging. The exclusion criteria were: endometrial carcinoma; leiomyosarcoma of uterus. Based on histopathologic examination results, the MR images of 36 patients were included in this study. Of which, 17 patients had uterine leiomyoma (mean age 48.8 years, age range 26–70 years), and 22 patients had uterine adenomyosis (mean age 48.5 years, age range 27–77 years). Within these patients, 3 patients had both leiomyoma and adenomyosis.

2.2. MR imaging

All the MR examinations were performed with a 3.0-T superconductive MR scanner (Siemens Magnetom Trio Tim 3.0T), using a six-channel SENSE torso coil. TSE T1WI in the axial plane (TR/TE 600 ms/8–12 ms, FOV 300 mm) with a section thickness of 5 mm, an intersection gap of 1 mm, matrix of 288 × 320, NEX = 2. TSE T2WI in the sagittal and axial planes (TR/TE 4000–4200 ms/100–120 ms, FOV 280 mm) with a section thickness of 4 mm, an intersection gap of 0.8 mm, matrix of 288 × 320, NEX = 2. DWI was obtained in the axial plane with a section thickness of 4 mm, an intersection gap of 0.8 mm and FOV of 280 mm using echo-planar imaging sequence (TR/TE = 3600/80 ms, 2 excitations, matrix of 128 × 128 with fat suppression technique). The corresponding *b* values to the diffusion-sensitising gradient were 0 and 1000 s/mm^2. ADC maps were derived automatically on a pixel-by-pixel basis from the DWI.

2.3. Image analysis

MR images and ADC values were retrospectively evaluated and measured in consensus by two experienced radiologists (Yang and Zhang). ADC maps were generated on the scanner console using $b = 1000$ and $b = 0$ images.