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ORIGINAL ARTICLE

Usefulness of diffusion-weighted magnetic resonance imaging for the characterization of benign and malignant renal lesions

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KEYWORDS

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Abstract *Purpose:* Our aim was to evaluate the diagnostic potential of diffusion-weighted magnetic resonance imaging (DW-MRI) and quantitative assessment of apparent diffusion coefficient (ADC) value for the characterization of renal lesions and differentiation into benign and malignant.
Patients and methods: A total of 87 consecutive patients with 107 renal lesions were enrolled in this prospective study. MRI examinations including DWI with *b* factors of 0, 600 and 800 s/mm^2 were performed at 1.5 T MRI unit. The mean ADC values of normal renal parenchyma, solid and cystic lesions were calculated.
Results: There was statistical significance difference between ADC value of normal renal parenchyma with that of benign (n = 60, 56%) and malignant (n = 47, 44%) renal lesions (P value < 0.0001). ADC values differed significantly between solid (n = 74, 69.2%) and cystic lesions (n = 33, 30.8%) (P value < 0.0001). There was significant difference between ADC values of all benign (n = 60, 56%) and malignant renal lesions (n = 47, 44%) (P value < 0.0001) but not between benign solid (n = 27, 36.5%) and malignant solid renal lesions (n = 47, 63.5%) (P value = 0.784).
Conclusion: There is overlap between the ADC values of benign and malignant lesions. The use of ADC value alone may lead to inaccurate assessment of renal lesions. Thus, DW-MRI should be interpreted in conjunction with conventional MRI sequences to allow for better characterization of renal lesions.

1. Introduction

Accurate assessment of renal masses is important for establishing whether tumors require surgical intervention or not. Computed tomography (CT) and magnetic resonance imaging (MRI) are the primary investigative tools for diagnosing,

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characterizing, and staging cystic or solid renal masses discovered incidentally by ultrasonography (1). However, MRI further characterized a large proportion of renal masses that were considered indeterminate at CT (2).

Diffusion weighted magnetic resonance imaging (DW-MRI) is a reasonable alternative to conventional cross sectional imaging to detect and characterize focal renal lesions, especially in patients with impaired renal function (3). The diffusion characteristics can be measured objectively and are represented in the form of apparent diffusion coefficient (ADC) values. So tissue diffusivity and, hence, diffusion-weighted imaging (DWI) can provide crucial diagnostic information regarding the architecture of various tissues and organs (4).

The aim of this study was to evaluate the diagnostic potential of DW-MRI and quantitative assessment of ADC value for the characterization of renal lesions and differentiation into benign and malignant.

2. Patients and methods

2.1. Patients

The study was approved by the hospital ethical committee, and an informed consent was obtained from all patients. During 2 years duration, we prospectively evaluated 87 consecutive patients (41 females, 46 males). They ranged in age from 15 to 71 years (mean 49.86 ± 15.82 year). All patients underwent renal MR imaging which included DWI for further evaluation and characterization of renal lesions previously detected by US and/or CT.

2.2. Methods

The MRI examinations were performed with a 1.5-T MRI system using two different MRI machines (Intera and Achieva; Philips Medical Systems, the Netherlands) equipped with a phased array body coil. For morphologic evaluation of the kidneys, respiratory triggered axial and coronal T2-weighted FSE sequences, axial T2-weighted spectral presaturation with inversion recovery (SPIR) with fat suppression was initially performed, followed by axial T1-weighted SE, and T1-weighted dual-echo in-phase and out-of-phase sequences. A bolus of 0.1 mmol/kg of gadopentetate dimeglumine-DTPA (Magnevist; Schering, Berlin, Germany) was injected intravenously followed by 20-mL saline flush. Three-dimensional fat-saturation T1-weighted dynamic contrast-enhanced sequences were performed during suspended respiration at baseline (pre-contrast), during the arterial phase, and 30 and 120–240 s after the arterial phase. Gadolinium was not administrated in 6 cases due to impaired renal function. MRI imaging protocol is demonstrated in Table 1.

Axial DWI was obtained by using a single-shot spin echo-planar sequence prior to the administration of contrast material. DWI was acquired with b value of 0, 600 and 800 s/mm^2.

2.3. Image analysis

All MRI images were transferred to an independent workstation (Philips MR extended workspace, software version 2009). Image interpretation and diagnosis were carried out by two radiologists (11 and 15 years experience in abdominal MRI imaging). After interpretation by Radiologist 1, Radiologist 2 confirmed the diagnosis, and in case of controversy, they discussed to reach a consensus.

First the conventional MRI images, including un-enhanced and contrast enhanced images were reviewed. The morphological features of each lesion were recorded including number, site, size, shape, together with signal characteristics, and enhancing pattern.

Based on conventional MRI findings, renal lesions were divided into solid and cystic groups. Cystic renal lesions were classified according to the Bosniak classification system (I, II, II F, III and IV), and Bosniak category IV lesions were evaluated in the solid group (5,6).

The DWI images, including the images obtained with b values of 0, 600, and 800 s/mm^2, were reviewed together. ADC values were measured for b value of 800 s/mm^2 by using circumferential region of interest (ROI). Necrotic portions or lesion margins were excluded from the ROIs. At least three measurements were performed and the lowest value was recorded for each b value. Circular ROIs were placed in the normal renal parenchyma (at the central portion of the kidney) for the measurement of ADC values.

2.4. Standard of references

The findings obtained using conventional MRI and DWI were compared with the results of the histopathological findings, clinical and imaging follow-up.

2.5. Statistical analysis

All statistical calculations were performed using SPSS software (version 21; SPSS Inc., Chicago, IL, USA). Comparison

Table 1 Magnetic resonance imaging protocol.

MR sequence	TR/TE (m sec)	Flip angle (°)	Slice thickness (mm)	Slice gap (mm)	NEX	Fat suppression	FOV (mm)
1-Axial T1 SE	425/15	90	7–8	1–2	1	–	350 × 275
2-Coronal T2 HASTE	1100/120	90	7–8	1–2	2	yes	360 × 140
3-Axial T1-out-of-phase	75-100/2.3	10	7–8	–	1	–	350 × 275
In-phase	75-100/4.6	10	7–8	–	1	–	350 × 275
4-Axial T2 TSE	4360/95	90	7	1–2	1	–	350 × 275
5-Axial T2 SPAIR	2000/80	90	7	1–2	1	yes	350 × 275
6-Axial T1 3D GRE	3.4/1.7	10	6	–	1	yes	350 × 275
7-DWI-B value 0, 600, 800	1500/80	90	6	–	4	yes	190 × 115

TSE, turbo spin echo; GRE, gradient recalled echo; DW, Diffusion-weighted; TE, echo time; TR, repetition time.