

Characterization of Renal Masses with Diffusion-Weighted MR Imaging -- A Preliminary Experience

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Introduction/Background

The presence of enhancing soft tissue in a renal lesion on cross-sectional imaging is considered diagnostic of a renal tumor. However, an extensively necrotic or cystic renal tumor may demonstrate little contrast enhancement, and its imaging appearance may overlap with that of complex benign renal cysts on conventional MR images. It has been shown that MR diffusion-weighted imaging (DWI) may be useful for characterization of renal lesions. However, to our knowledge, data on DWI of focal renal lesions are sparse in the literature and no study has been performed to compare the apparent diffusion coefficient (ADC) values of nonenhancing tumor tissue with those of cysts in the kidney.

Purpose

To describe the apparent diffusion coefficient (ADC) values in various types of renal lesions (viable solid tumor versus necrotic/cystic tumor versus benign cysts).

Materials and Methods

Between October 2005 and September 2006, 28 consecutive patients who underwent renal MRI and subsequent nephrectomy were included in this study. MRI exams were performed on a 1.5 T scanner with a body phased-array coil. In addition to routine T1 in- and out-of-phase, T2 single-shot fast spin-echo, and 3D fat-saturated contrast-enhanced sequences, breath-hold axial diffusion-weighted images were obtained using a single-shot spin-echo echo planar imaging (SE EPI) sequence (TR 1800 ms, TE 90 – 104 ms, flip angle 90°, field of view 36 – 42 cm, matrix 128 x 128, slice thickness/gap 7/1 mm, all directions, number of acquisitions 1), with *b* values of 0, 500 and 1000 s/mm². Pixel-by-pixel ADC maps were generated using commercial software. Largest possible round or elliptical regions of interest (ROIs) were placed on renal lesions to evaluate the ADC values of whole lesions. When the renal lesion was heterogeneous, smaller ROIs were placed on areas of enhancing viable soft tissue and nonenhancing necrotic or cystic areas. The T1 characteristics of the renal lesions and the necrotic or cystic areas were also recorded. Depending on lesion size, up to three regions of interest (ROIs) were positioned in each renal mass, viable or necrotic/cystic area. When more than one ROI was placed for each lesion or area, the mean ADC value was calculated.

Results

Twenty-five of 28 diffusion-weighted MR exams demonstrated good image quality and were included for analysis. Twenty-six tumors were found on surgical pathology, including 10 clear cell, 5 papillary, 3 chromophobe, and 2 unclassified renal cell carcinomas, 3 other malignant renal tumors (angiosarcoma, collecting duct carcinoma, primitive neuroectodermal tumor (PNET)), 1 angiomyolipoma and 2 oncocytomas. Sixteen of 26 tumors demonstrated areas of necrotic or cystic changes, evidenced by lack of contrast enhancement on MR. Eight lesions demonstrated T1 hyperintense necrotic/cystic areas, 12 demonstrated T1 hypointense necrotic/cystic areas. In addition, 20 benign cysts were found, 4 with T1 hyperintensity, 16 with T1 hypointensity. Significantly different ADC values were observed for the various types of lesions ($p < 0.005$, Table 1). The number of lesions in each histological subtype was too few to perform a formal analysis (Table 2).

	Whole tumor	Viable tumor	High T1 necrotic tumor	Low T1 necrotic tumor	High T1 cysts	Low T1 cysts
ADC (mean \pm SD)	1.88 \pm 0.43	1.72 \pm 0.48	1.64 \pm 0.60	2.60 \pm 0.24	2.58 \pm 0.57	3.37 \pm 0.53

	Clear Cell	Papillary	Chromophobe	Unclassified	Oncocytoma	Angiomyolipoma
ADC (mean \pm SD)	2.03 \pm 0.10	2.07 \pm 0.17	1.50 \pm 0.30	1.26 \pm 0.24	2.16 \pm 0.02	1.23

* ADC = value $\times 10^{-3}$ mm²/sec.

Discussion

These preliminary data demonstrate that different renal lesions have different diffusion characteristics. Simple T1 hypointense renal cysts have the highest ADC values. T1 hyperintense (hemorrhagic or proteinaceous) benign renal cysts have diffusion values similar to those of T1 hypointense (nonhemorrhagic) necrotic or cystic areas in renal tumor, but they can be differentiated based on the T1 signal intensity. T1 hyperintense (hemorrhagic) necrotic or cystic areas in renal tumor demonstrate low ADC values, similar to those of viable solid tumor tissue. Therefore ADC may be potentially used as an incremental parameter to characterize renal lesions.

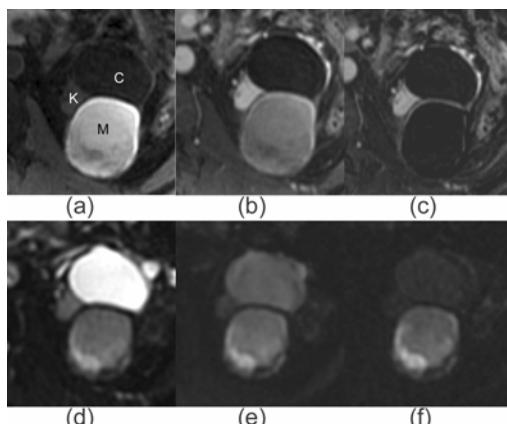


Figure. Left renal angiosarcoma that was shown to contain large necrotic areas on surgical pathology.

(a) Precontrast T1 image demonstrates a T1 hyperintense mass (M) in the left kidney (K). A simple cyst (C) is seen in anterior left kidney. (b) Postcontrast T1 image shows no obvious enhancement in either renal lesion, which is confirmed by (c), subtracted image. (d) DWI *b*=0; (e) *b*=500; (f) *b*=1000, show high signal maintained in the tumor with increasing *b* values, whereas the cyst shows decreased signal.

References

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