European Journal of Radiology 82 (2013) 1870–1876

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Pseudotumours in chronic kidney disease: Can diffusion-weighted MRI rule out malignancy

Ankur Goyal [a], Raju Sharma [a,*], Ashu S. Bhalla [a], Shivanand Gamanagatti [a], Amlesh Seth [b]

[a] Department of Radiodiagnosis, All India Institute of Medical Sciences (A.I.I.M.S.), New Delhi, India
[b] Department of Urology, All India Institute of Medical Sciences (A.I.I.M.S.), New Delhi, India

ARTICLE INFO

Article history:
Received 27 March 2013
Received in revised form 3 June 2013
Accepted 8 July 2013

Keywords:
Diffusion weighted MRI
Renal pseudotumour
Renal cell carcinoma
Indeterminate renal lesion
Chronic kidney disease

ABSTRACT

Objectives: To evaluate whether diffusion-weighted MRI (DW-MRI) can distinguish pseudotumours in chronic kidney disease (CKD pseudotumours) from renal-cell-carcinomas (RCCs) (with or without CKD) and whether it offers additional benefit over conventional MRI.
Methods: One-hundred patients underwent MDCT, MRI and DW-MRI (at *b*-values of 0 and 500 s/mm^2) for evaluation of focal renal lesions. Of these, 20 patients with 40 CKD pseudotumours and 36 patients with 40 RCCs were retrospectively analyzed. T1-weighted, T2-weighted, diffusion-weighted images were evaluated, apparent-diffusion-coefficient (ADC) values were compared and receiver-operating-characteristic (ROC) curves were drawn to establish cut-off ADC-values.
Results: 92.5% of CKD pseudotumours remained indeterminate after conventional MRI. On DW-MRI, none of them showed restricted diffusion and thus malignancy could be ruled out in 100% of the lesions. In contrast, all the solid RCCs showed diffusion restriction. Mean ADC-value for CKD pseudotumours was significantly higher than RCCs and surrounding diseased parenchyma [2.50 vs 1.56 ($\times 10^{-3}$ mm^2/s) ($P < 0.0001$) and 2.05 ($\times 10^{-3}$ mm^2/s) ($P = 0.0001$) respectively]. ROC analysis for differentiating CKD pseudotumours and RCC yielded high sensitivity (91.7%) and specificity (100%) for cut-off ADC-value of 2.04 ($\times 10^{-3}$ mm^2/s).
Conclusions: CKD pseudotumors usually remain indeterminate on conventional non-contrast MRI. DW-MRI can distinguish CKD pseudotumors from RCCs and offers a non-contrast non-invasive alternative for ruling out malignancy.

1. Introduction

The disease burden of chronic kidney disease (CKD) is increasing worldwide, making it a major public health problem [1]. The common causes of chronic kidney disease include hypertension, diabetes, glomerulonephritis, interstitial nephritis and ischemic nephropathy. Keeping in view the risk of contrast-induced-nephropathy with iodinated contrast used in CT and of nephrogenic systemic fibrosis with gadolinium-based contrast used in MRI; non-contrast imaging modalities are an ideal choice in these patients.

Despite all imaging advancements, the incidence of benign pathology at surgery for suspected renal malignancy remains high [2]. Certain lesions may mimic tumors on imaging, but are histologically composed of normal or benign renal tissue. Such pseudo-mass lesions are termed renal pseudotumours and may be developmental, infectious, granulomatous or vascular in etiology [3]. Some of these pseudotumours may be diagnosed confidently on imaging, but few are inevitably resected because of the concern about malignancy and lack of diagnostic certainty.

Normal renal tissue is capable of undergoing hypertrophy and hyperplasia following loss of nephrons due to injury or surgery, and this may be focal or diffuse [4,5]. Pseudotumours are often seen in kidneys which are scarred and deformed by chronic pyelonephritis, glomerulonephritis, trauma or infarction [4–10]. This represents focal nodular compensatory hypertrophy of relatively preserved renal parenchyma in chronic kidney diseases. Such focal regenerating nodules may produce mass effect in the form of contour abnormality or endophytically splaying/compressing the pelvi-calyceal system [5], thus closely simulating renal neoplasm. Clinicians and radiologists must be aware of the imaging appearance of these pseudotumours so as to avoid inadvertent surgeries, which may deprive the patient of precious remaining functional parenchyma.

Abbreviations: MDCT, multidetector computed tomography; MRI, magnetic resonance imaging; CKD, chronic kidney disease; DW-MRI, diffusion-weighted MRI; ADC, apparent diffusion coefficient; ROC curve, receiver operating characteristic curve.

* Corresponding author at: Department of Radiodiagnosis, All India Institute of Medical Sciences (A.I.I.M.S.), Ansari Nagar, New Delhi 110029, India.
Tel.: +91 9868398802.
E-mail addresses: ankurgoyalaiims@gmail.com (A. Goyal), raju152@yahoo.com (R. Sharma), ashubhalla1@yahoo.com (A.S. Bhalla), shiv223@rediffmail.com (S. Gamanagatti), amlesh.seth@gmail.com (A. Seth).

0720-048X/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ejrad.2013.07.008

There is paucity of literature regarding the imaging appearance of pseudotumours in CKD. Majority of the earlier reports [4–7] have discussed the urographic and angiographic appearance of these lesions, which is of limited use in the present era. Due to the presence of renal dysfunction in these patients, definitive imaging criteria on non-contrast modalities are needed to rule out malignancy. Previous investigators including our group have evaluated the utility of diffusion-weighted MR Imaging (DW-MRI) in characterization of focal renal lesions [11–19], renal parenchymal disease [13,20–23] and renal infections [19,24,25]. However, there are no prior reports on the role of DW-MRI in differentiating CKD pseudotumours from renal tumors.

The purpose of this study was to investigate whether DW-MRI coupled with apparent diffusion coefficient (ADC) values can be used to distinguish CKD pseudotumours from renal cell carcinomas (RCCs) (with or without CKD) and whether it offers additional benefit over conventional MRI. RCCs in background of CKD are likely to have similar imaging morphology as RCCs arising in normal kidneys. Besides, the prevalence of CKD patients with RCC is low, which precludes a direct comparison between CKD pseudotumors and RCCs in CKD patients. Thus, comparison of CKD pseudotumors with RCCs (with or without CKD) is rational and the results may be extrapolated to infer the role of DW-MRI in characterizing renal lesions in CKD patients.

2. Materials and methods

2.1. Subject population, data collection and gold standard

A prospective study to evaluate focal renal mass lesions using MDCT and MRI along with DW-MRI was undertaken at our institute from November, 2008 to July, 2011. The study was approved by the Institutional Ethics Committee and informed consent was taken from all the patients. Adult patients (≥18 years) presenting with clinical features suspicious of renal mass lesion or sonographically detected renal masses requiring further imaging work-up were included. A total of 100 patients underwent MDCT, MRI and DW-MRI (at *b*-values of 0 and 500 s/mm^2) for characterization of focal renal lesions. This study is a retrospective evaluation of the prospectively collected data, relevant to the subject in discussion. All data including demographic information, clinical and laboratory profile and pathological findings were collected by one author.

On retrospective analysis of these 100 patients, twenty patients were found to have 40 pseudotumours in chronically diseased kidneys (CKD pseudotumours) and thirty-six patients had 40 pathologically-proven RCCs. The reference standard for the final diagnosis in pseudotumours was ultrasound-guided biopsy of renal lesion or lesion stability for at least 1 year (documented by 3-monthly follow-up sonographic evaluation).

2.2. MRI

All patients underwent MR Imaging at 1.5 Tesla (Siemens, Avanto, Erlangen, Germany) (maximum gradient strength 45 mT m^{-1}, maximum slew rate 200 mT m^{-1} s^{-1}) in the supine position using a phased-array body coil. Two anteriorly placed 6-element body matrix coils and two posterior spine clusters (3 channels each) were employed to optimize the signal-to-noise ratio (SNR). The imaging protocol is shown in Table 1. Dynamic contrast-enhanced MR was performed using gadobenate dimeglumine (MultiHance, Bracco, Milan, Italy), injected via a dual head pressure injector (Spectris Solaris, Medrad, Philadelphia, Pennsylvania, USA) at the rate of 2 mL/s followed by 20 mL saline flush at the same rate. The dose employed was 0.1 mmol/kg body weight and contrast medium was withheld if the estimated GFR was less than 30 mL/min/1.73 m^2.

2.3. DW-MR Imaging

Respiratory triggered FS (spectral fat suppression) spin echo-echo planar imaging (SE-EPI) axial diffusion-weighted sequence at *b* values of 0 and 500 s/mm^2 was done before contrast administration, using parallel imaging based on generalized autocalibrating partially parallel acquisition (GRAPPA) with twofold acceleration factor and diffusion gradients applied in all three orthogonal directions separately. The parameters used are shown in Table 1 and acquisition time was 2–4 min (depending on patient's respiratory cycle). The DW sequence was respiratory triggered using navigator-triggered prospective acquisition correction technique (PACE) in which diaphragmatic position is assessed periodically by navigator echoes. Trace diffusion-weighted images and ADC maps were derived automatically on a voxel-by-voxel basis.

2.4. Image analysis

To minimize subjectivity, the imaging data was reviewed by 3 radiologists (having 20, 15 and 10 years of experience in abdominal MR Imaging) in consensus, blinded to the final diagnosis. Signal intensity of the renal lesions on T1 and T2-weighted images was analyzed. The diffusion-weighted images at *b* 0 and 500 s/mm^2 were qualitatively assessed to evaluate whether the renal lesion exhibited diffusion restriction. If the signal on *b* 500 s/mm^2 images remained the same or showed minimal decrease as compared to the *b* 0 s/mm^2 image, this was taken as restricted diffusion. If the lesion showed definite loss of signal on *b* 500 images, this was taken as no diffusion restriction. The DW images were analyzed in conjunction with ADC maps (to avoid T2 effects) in which lesions showing restricted diffusion were hypointense and those with unrestricted diffusion were hyperintense relative to the normal renal parenchyma.

Regions of interest (ROIs) for quantitative measurement of ADC were placed on a commercial workstation by a single radiologist, blinded to the final diagnosis. The following standard technique was employed: to measure the representative ADC of the renal lesion (ADC_{lesion}), circular ROIs (with minimum area of 1 cm^2) were placed on the lesion in the areas showing restricted diffusion. This corresponded to the solid enhancing areas of neoplastic lesions. Care was taken to avoid necrotic/cystic/hemorrhagic areas within them. In case of renal lesions not showing diffusion restriction, ROI was placed in the most homogeneous portion. ADC value from single ROI (for lesions < 2 cm) or mean value from multiple ROIs (for lesions > 2 cm) was considered as representative ADC of the renal lesion. Mean ROI size for ADC_{lesion} measurement was 2.5 cm^2 (range 1–10.66 cm^2). To measure the ADC of surrounding kidney ($ADC_{parenchyma}$), circular ROI of size 1 cm^2 was placed on the contralateral normal renal parenchyma, without any preference for cortex/medulla. The ADC values were expressed as mean ± standard deviation in the form of $A \times 10^{-3}$ mm^2/s up to two decimal places.

Since none of the 40 CKD pseudotumours showed diffusion restriction, so ROIs for ADC_{lesion} were placed in their most homogeneous portions. Rest of the renal parenchyma in these cases was seen to exhibit multiple peripheral-based wedge-shaped foci of restricted diffusion, becoming confluent at places. Hence $ADC_{parenchyma}$ in these patients was taken in an area of renal parenchyma free from the pseudotumours as well as free from these foci of restricted diffusion. In five patients, these foci of restricted diffusion involved the entire kidneys and thus