



Diagnostic value of multidetector computed tomography for renal sinus fat invasion in renal cell carcinoma patients



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ARTICLE INFO

Article history:

Received 11 November 2013

Received in revised form 27 February 2014

Accepted 28 February 2014

Keywords:

Diagnostic performance

Multidetector computed tomography

Renal cell carcinoma

Renal sinus fat invasion

Staging

ABSTRACT

Objective: Although renal sinus fat invasion has prognostic significance in patients with renal cell carcinomas (RCCs), there are no previous studies about the value of multidetector computed tomography (MDCT) about this issue in the current literature.

Materials and methods: A total of 863 consecutive patients (renal sinus fat invasion in 110 patients (12.7%)) from single institutions with surgically-confirmed renal cell carcinoma who underwent MDCT between 2010 and 2012 were included in this study. The area under the curves (AUCs) of the receiver operating characteristic (ROC) analysis was used to compare diagnostic performance. Reference standard was pathologic examination. Weighted κ statistics were used to measure the level of interobserver agreement. Multivariate logistic regression model was used to find the predictors for renal sinus fat invasion. Image analysis was first performed with axial-only CT images. A second analysis was then performed with both axial and coronal CT images. A qualitative analysis was then conducted by two reviewers who reached consensus regarding tumor size, decreased perfusion, tumor margin, vessel displacement, and lymph node metastasis. The reference standard was pathologic evaluation.

Results: The AUCs of the ROC analysis were 0.881 and 0.922 for axial-only images and 0.889 and 0.902 for combined images in both readers. The AUC of tumor size was 0.884, a similar value to that of the reviewers. In multivariate analysis, tumor size, a linear-nodular or nodular type of fat infiltration, and an irregular tumor margin were independent predicting factors for perinephric fat invasion.

Conclusion: MDCT shows relatively high diagnostic performance in detecting perinephric fat invasion of RCC but suffers from a relatively low PPV related to low prevalence of renal sinus fat invasion. Applying tumor size alone we could get similar diagnostic performance to those of radiologists. Tumor size, fat infiltration with a nodular appearance, and an irregular tumor margin were predictors for perinephric invasion.

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1. Introduction

Renal cell carcinoma (RCC) comprises 1–3% of all visceral neoplasms and is the most common malignant tumor of the kidney, accounting for 85–90% of all malignant renal tumors in adults. Furthermore, the incidence of RCC has been steadily increasing over recent decades due to the increasing use of cross-sectional imaging [1–3].

Renal sinus fat invasion is a prognostic factor for disease-free and cancer-specific survival in RCC patients [4–7]. Since 2002, tumors with renal sinus fat invasion have been characterized as T3a stage by the American Joint Committee on Cancer TNM system, in addition to tumors with perinephric fat invasion and direct invasion of the ipsilateral adrenal gland [8,9]. Recent reports suggested that renal sinus fat invasion alone or in combination with perirenal fat invasion increases the risk of metastasis and is associated with poor prognosis of RCC patients [5,10,11]. Furthermore, Thompson et al. reported that 67% patients who die from RCC have undiagnosed renal sinus fat invasion or small renal vein invasion [12]. Consequently, accurate preoperative diagnosis of renal sinus fat invasion is important to predict the prognosis of RCC patients.

Computed tomography (CT) is the optimal modality for characterizing and staging renal tumors. Multidetector computed

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Table 1
Patients characteristics.

Characteristic	No. of patients	%
Age, years		
Mean	55.1	
Range	16–84	
Sex		
Male	254 (29.4)	
Female	609 (70.1)	
Tumor size, mm		
Mean	47.4	
Range	6–690	
Tumor stage (pathology)		
T1a	528	61.2
T1b	128	14.8
T2a	72	8.3
T2b	11	1.3
T3a	118	13.7
T3a (renal sinus fat invasion)	110	12.7
T3b	1	0.1
T3c	1	0.1
T4	4	0.5
Pathology		
Clear cell type	720	83.4
Papillary type	53	6.1
Chromophobe type	78	9.0
Multilocular cystic renal cell carcinoma	6	0.7
Unclassified type	3	0.3
Mixed type	2	0.2
Sarcomatoid type	1	0.1
All	863	

tomography (MDCT) has allowed radiologists to overcome the limitations of single-detector helical CT by providing volume data that can be reformatted in various planes, which helps to determine complex renal tumors. However, the diagnostic performance of MDCT for the detection of renal sinus fat invasion in RCC patients has not been reported.

The aim of this study was to evaluate the usefulness of MDCT in the preoperative evaluation of renal sinus fat invasion in RCC patients, and to identify radiological features that are predictive of renal sinus fat invasion in RCC patients.

2. Materials and methods

2.1. Patient selection

To assess the accuracy of MDCT, the data of 1,056 patients who underwent partial or radical nephrectomy for RCC at our institute between February, 2010, and December, 2012, was retrospectively analyzed. All patients underwent contrast-enhanced CT for preoperative staging. This retrospective study was approved by the Asan Medical Center institutional review board for retrospective studies; informed consent and formal approval were waived. A total of 193 patients were excluded from the study for the following reasons: lack of coronal reconstructed images (124 patients), poor image quality (60 patients), and underlying diseases such as polycystic kidney disease, acquired cystic disease, von Hippel-Lindau disease and horseshoe kidney (9 patients). Therefore, 863 patients (254 men and 609 women; age range, 16–84 years; mean age, 55.1 years) were included in the study. The patient characteristics are shown in Table 1.

2.2. Study parameters

Gender, age, and histologic subtype were recorded. Tumor size was evaluated from the CT images. TNM stage was determined by the pathologists according to the 2009 classification and pTNM staging was the standard reference of this study. Tumors that grossly extended into the renal vein or its segmental branches, or

that invaded perirenal and/or renal sinus fat but did not extend beyond Gerota's fascia, were defined as pT3a stage. The presence of renal sinus fat invasion was separately recorded. Data concerning the surgical technique was not collected.

2.3. CT imaging technique

CT imaging was performed with a 64-channel (LightSpeed VCT, GE Medical systems, Milwaukee, WI, USA) or a 16-channel (SOMATOM sensation 16, Siemens, Erlangen, Germany) MDCT scanner. The CT scan parameters for the 16-channel scanner were as follows: a tube voltage, 120 kVp; a tube current, 200–400 mA; detector coverage, 40 mm; Beam collimation, 0.75 mm for 16-channel MDCT and 0.6 mm for 64-channel MDCT; Rotation time, 0.5 s; Pitch, 1.0; reconstructed image thickness, 5 mm in unenhanced and nephrographic phase, 3 mm in corticomedullary and excretory phase; reconstruction interval, 5 mm in unenhanced and nephrographic phase, 3 mm in corticomedullary and excretory phase. Oblique coronal reconstruction was performed for corticomedullary imaging parallel to the renal axis.

2.4. Image analysis

Preoperative contrast-enhanced CT images were independently evaluated by two radiologists (C.H.J., and K.C.R., who have 12 and 3 years of experience interpreting urological CT images, respectively) in a random order and in a blinded manner. Although the reviewers knew that all patients had confirmed RCC, they were unaware of the tumor location, the tumor size, the pathologic stage of the tumor, or the presence of renal sinus fat invasion. All images were evaluated with a PACS workstation and the optimal window settings were adjusted in each case. In the first session, the reviewers were provided with axial CT images only. Three weeks after the first session, the reviewers were provided with axial and coronal CT images in the second session. In this way, the usefulness of coronal images for predicting renal sinus fat invasion in RCC patients was determined. The two reviewers interpreted the images independently in both sessions.

Each reviewer independently scored the CT images in the first and second sessions for the possibility of renal sinus fat invasion using a five point confidence level scoring system as follows: 1, definitely absent; 2, probably absent; 3, possibly present; 4, probably present; and 5, definitely present. Scoring was recorded in each session separately.

In addition, 3 weeks later after the second session, the two reviewers performed qualitative analysis of the CT scans by consensus and assessed tumor size, kidney perfusion (enhancement degree compared with the contralateral kidney), tumor margin (smooth or irregular), vessel displacement (moved renal sinus vessels by the tumor in renal sinus), and regional lymph node metastasis.

All surgical specimens were evaluated based on the pathologic TNM staging system developed by the American Joint Committee on Cancer. For all patients, preoperative MDCT imaging results were compared with the histopathological results of resected specimens.

2.5. Statistical methods

To investigate the diagnostic ability of MDCT to identify renal sinus fat invasion in RCC patients, receiver operating characteristic (ROC) curves were plotted for each reviewer, and tumor size. The accuracy of the ROC curve was determined by measuring the area underneath it (AUC). The following data were compared: (a) the reviewers' interpretations from the first session (axial images only) and tumor size, (b) the reviewers' interpretations from the second session (axial and coronal images) and

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