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Diagnostic value of contrast enhanced computed tomography in detection of renal sinus fat invasion in renal cell carcinoma patients taking histopathology as gold standard

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Abstract

Introduction: Renal sinus fat invasion is one of the most common stage T3a finding in renal cell carcinoma. The detection of renal sinus fat invasion is important as it helps in planning the treatment modality. Multidetector contrast enhancement CT scan is one of the most common modalities used for staging purpose in RCC.

Objective: In our study we aim to determine the diagnostic value of multidetector CT scan in detection of renal sinus fat invasion in RCC patients taking histopathology as gold standard.

Material and Methods: All the patients with diagnosed RCC (stage T1a, T1b, T2 and T3a) were included in our study. The preoperative CT scans of all the patients were assessed for the presence of renal sinus fat invasion by two experienced radiologists. The results were evaluated for sensitivity, specificity, positive and negative predictive value taking histopathology as gold standard.

Results: A total 143/284 (51.4%) patients were at stage T3a out of which renal sinus fat invasion was seen in 117/143 (82%) patients. The multidetector enhancement CT scan findings for renal sinus fat invasion by two radiologists depicted a mean sensitivity of 88%, specificity 73%, 52% positive predictive value and 95% negative predictive value. The size, laterality and polarity did not show a significant correlation ($p > 0.05$)

Conclusion: MDCT is a useful tool in the exclusion of renal sinus fat invasion owing to its high negative predictive value. Although it has a good sensitivity for renal sinus fat involvement however due to low specificity and positive predictive value it cannot be totally relied upon for invasion. Other factors like size, irregular tumor margins, nodular enhancement of renal sinus fat and location of tumor lesion should also be correlated.

Keywords: Renal cell carcinoma, renal sinus fat invasion, computed tomography

1. Introduction

Renal Cell carcinoma (RCC) arises from specialized cells lining the nephron and has several histological types including papillary cell RCC, clear cell RCC, chromophobe RCC, collecting duct RCC and oncocytoma [1]. It has shown increased incidence in the past few decades rising 2-4% per year with the highest mortality rate among all genitourinary tumors [2].

The increased incidence of RCC has been attributed to better ability to detect the lesion through advanced imaging modalities. CT scan is the mainstay imaging technique when it comes to renal masses owing to its cost effectiveness, high resolution and reproducibility [4]. Renal cell carcinoma staging is done using TNM method in which local spread of tumor, nodal status and distant metastasis is evaluated. As per TNM scoring, In T1 and T2 stages, tumor is confined to the kidney, however invasion of perinephric and renal sinus fat is classified among pT3 RCC following American Joint Committee on Cancer Guidelines 2002 [3]. Renal sinus fat invasion has a prognostic significance as it is associated with more aggressive RCC as compared to perinephric fat invasion [5].

Surgical management of RCC varies depending on the local staging of the tumor i.e. if renal sinus fat is not invaded by the tumor, nephron sparing surgery/radiofrequency ablation can be opted; however, if there is renal sinus fat invasion, plan for partial versus radical nephrectomy is planned [6].

In our study we aim to determine the sensitivity, specificity and positive predictive value of contrast enhanced multi detector contrast enhanced CT scan in detecting renal sinus fat invasion in RCC patients. This will help in prediction of renal sinus fat invasion before proceeding to surgery hence can lead to better outcome.

2. Objective

To determine the diagnostic value of CT scan in detection of renal sinus fat invasion in RCC patients taking histopathology as gold standard.

3. Material and Methods

It is a retrospective cross-sectional study conducted at Radiology Department, Shaukat Khanum Cancer and Memorial Hospital Lahore for a period of 5 years from 1st January 2015 to 1st January 2020.

All the diagnosed patients of stage T1, T2 and T3a RCC in the specified time of both genders, age 18 and above diagnosed on histopathology will be included. Patients at stage T3b and stage T4, those who received any chemotherapy or radiotherapy treatment prior or after the CT scan acquisition were excluded. Also, the patients who did not have any preoperative CT scan or have a CT scan done more than 3 months prior to surgery were excluded.

After taking permission from the institute review board, the previous data of patients presenting with RCC diagnosed with stage T1, T2 and T3a on histopathological analysis will be reviewed. Patients' presenting complaints and previous medical and treatment history will be assessed keeping full confidentiality of all the records. The multidetector contrast enhanced computed tomography (CT) of the chest, abdomen performed on 64 slice Toshiba scanners of each patient will be analyzed in detail. Further analysis will be done using coronal and axial images of CT scan. Renal sinus fat invasion will be assessed trained radiologist who have at least 5 years of experience in the field by taking three diagnostic signs including irregular tumor margins, nodular fat tissue and enhancement of the tumor mass within the sinus region. Details including size of tumor, margins, invasion, perfusion, vessel and lymph node involvement will be noted. The findings obtained for each patient will be

correlated with histopathological report for formulation of our results.

Data analysis will be done using SPSS version 21 using inferential tests for descriptive analysis.

4. Results

Our study included total 284 patients with stage T1a, T1b, T2 and T3 over a time span of 3 years. Around 30 patients were presented with stage T3b, 10 patients with stage T3c and 38 patients were at stage T4 who all were excluded. The mean age of presentation was 51.77 years with a standard deviation of 12.153 with the most common age range was 50 to 60 years. The age limit was 21 to 82 years. The male to female ratio showed a male predominance with 1.58:1. Around 61% patients were male and 39% patients were female. The mean size of the tumor at presentation was 7.1cm.

On histological classification, it was observed that clear cell carcinoma being the most common was seen in 62.5% patients, papillary cell carcinoma was present in 33.6% patients. Rest of the patients had chromophobe, collecting duct and other miscellaneous types of RCC.

The staging done on histology is shown in Table 1.

Table 1

Stage	No. of patients	N%
Stage T1a	35	12%
Stage T1b	70	24%
Stage T2	36	12.6%
Stage T3a	143	51.4%

In all 143 patients of stage T3a, renal sinus fat invasion was present in 117 (81.8%) patients, followed by perinephric fat infiltration seen in 70 (48.9%) patients and renal vein invasion present in 33 (23.1%) patients.

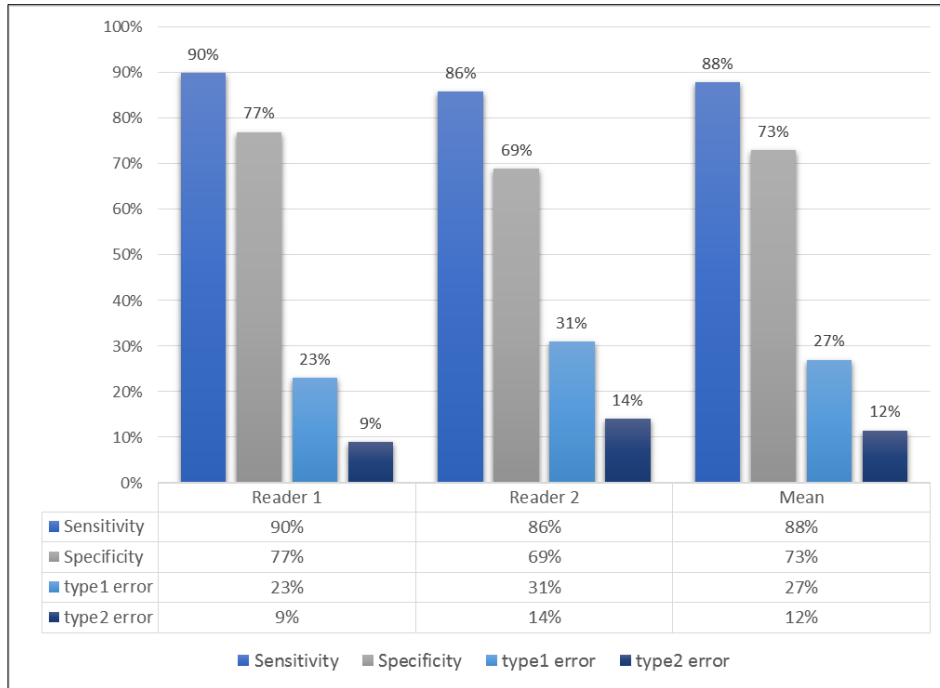
The CT scan findings of patients with renal sinus fat invasion were assessed by two experienced radiologists. Their results were obtained in the predetermined diagnostic criteria given for renal sinus fat invasion on CT scan. The individual results of sensitivity and specificity was obtained as shown in table. K value was calculated to show the agreement between the two radiologists that came out to be good for both diagnostic signs of renal sinus fat invasion.

Table 2

Symmetric Measures					
		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Measure of Agreement	Kappa	.856	.031	14.500	.000
a. Not assuming the null hypothesis.					
b. Using the asymptotic standard error assuming the null hypothesis.					

The mean sensitivity and specificity of the two readers came out to be 88% and 70% respectively. Positive predictive

value came out to be 52% and negative predictive value was 95%. Details are shown in the



Graph 1

Table 3

	Reader 1	Reader 2	Mean
Positive predictive value	56%	48%	52%
Negative predictive value	96%	94%	95%

The correlation of Renal sinus fat invasion patients was established with gender, age, size, laterality and polarity of the tumor lesion. Around 52 (73.2%) of those patients were male and 19 (26.8%) patients were females with a mean age of 50 years.

It was observed that no significant correlation was seen with

laterality and polarity of the tumor lesion with a p value >0.05. It was also noted that increased size of the tumor was seen in 45 (38.4%) with a size >7cm and remaining 72 (61.5%) had tumor size <7cm making it an unreliable factor. However, most of the tumor lesions were centrally located in stage T3a making it a significant finding.

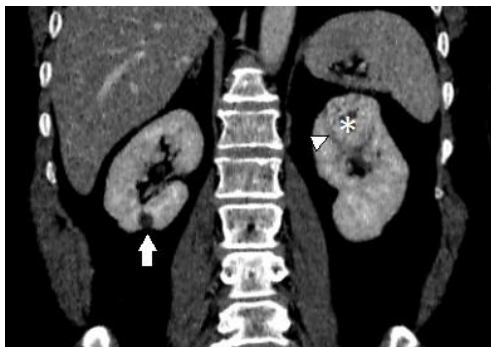


Fig 1

Figure: 1

65 year old female with left flank pain for 2 months. Also complains of episodes hematuria off and on for 1 year. CECT coronal image showing a well circumscribed left renal upper pole mass (asterisk) with most of its bulk endophytic in nature. Note that it has well demarcated margins (arrow head) and does not invade into the renal sinus fat. The tumor was 3.7cm in maximum dimension and was staged as T1a. No sinus fat invasion. A simple renal cortical cyst is also noted at the lower pole of the right kidney (arrow).



Fig 2

Figure: 2

66 year old male with vague abdominal pain. On initial ultrasound there was noted a left renal mass. CECT coronal image showing a heterogenous hypo-enhancing mass involving the mid and lower poles of the left kidney (arrow). Note that the lesion is extending into the renal hilum; however there are relatively well defined margins with sinus fat. (Arrow head) No evidence of nodular or irregular margins to suggest sinus fat infiltration. On CT scan based on its size the lesion was categorized as T2a and was confirmed on histopathology.



Fig 3



Fig 4

Figure: 3
66 year old male with history of hematuria for 1 month. CECT shows a large heterogenous mass arising from the upper pole of the left kidney (arrow) there can be seen that irregular margins with sinus fat (arrow head). Central necrosis also identified (asterisk). This was further proven to be T3a due to sinus fat infiltration on histopathology.

presentation. Was initially treated on lines of urinary tract infection; however, ultrasound showed a left renal mass for which CT scan was performed. Figure shows CECT coronal image showing a solid mass arising from the mid pole of the left kidney (asterisk) with both exophytic as well as endophytic component. It was initially reported to have invaded into the renal sinus fat. On retrospective analysis it can be seen that the lesion has well defined margins with renal hilum (arrow) of note is presence of non-obstructing renal calculi in left renal lower pole (arrow head).

Figure: 4
52 years male had concretions in the urine 4 months before



Fig 5



Fig 6a

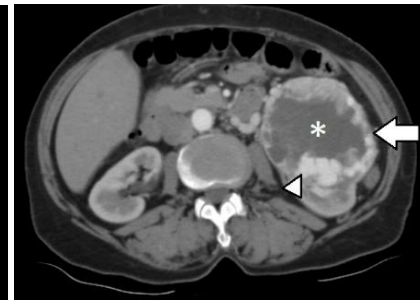


Fig 6b

Figure: 5
77-year-old male with history of lower urinary tract symptoms for 3 months. Underwent TURP. Also had history of chronic smoking. On ultrasound there was a left renal mass for which CT scan performed. CECT coronal slice shows a hypo enhancing left renal tumor infiltrating the upper pole (arrow). Note that it has no clear margins especially along the renal hilum as represented by asterisk. However the renal sinus fat is still not invaded. Initially this was regarded as T3a tumor with sinus fat invasion; however biopsy negated that finding.

enhancing component close to the hilum was suggestive of vascular in nature. (Arrow head) central necrosis again seen (asterisk).

Figure: 6a
55 year old female with left lumbar pain since 6 months. No hematuria or weight loss noted. CECT axial slice showing a heterogenous solid mass arising from the mid-lower pole of the left kidney (arrow). Central necrosis is also identified (asterisk). The tumor was categorized to be T2b on radiological staging due to its relatively well-defined borders, while the hyper enhancing components close to the hilum were considered to vessels (arrow head). This was further turned out to be T3a due to sinus fat infiltration on pathological evaluation.



Fig 7

Figure 6b
Same patient with CECT sagittal reconstruction image shows a heterogenous lesion at mid-lower pole (arrow) with relatively defined margins with renal hilum. Note the hyper

Figure 7
A 41 year old male patient with history of painless hematuria for 2 months. CECT axial slice shows a heterogenous mass in the right kidney mid pole (asterisk) mostly central in location with all its bulk endophytic. There is nodular irregular margins of the tumor and has a frank infiltration into the renal hilum as well as into the renal vein (arrow head) This was further turned out to be positive for

renal sinus fat as well as renal vein invasion on pathology sample.

5. Discussion

Stage T3 of renal cell carcinoma is further divided into T3a (renal sinus fat invasion, perinephric fat invasion, and renal vein invasion not beyond gerota fascia) T3b (infradiaphragmatic IVC involvement) and T3c (supradiaphragmatic IVC involvement) [7].

It has been associated with a poor prognosis thus is the main focus of many studies currently done on renal cell carcinoma [8]. Also the treatment modalities are different when it comes to T3a, as it can be surgically removed by partial nephrectomy in most of the cases hence the accurate diagnosis in the mainstay of the treatment [6].

We have focused on stage T3a exclusively on renal sinus fat invasion in our study. Previously different studies are done focusing the radiological features and accuracy of stage T3a as a whole or perirenal fat invasion alone [9, 10]. Such a study has not been reported in our country before. Also, renal sinus fat invasion is the most common stage T3a findings as demonstrated in previous studies [11]. It was seen that renal sinus fat invasion was seen in almost 117/143 (82%) of all the patients who presented with stage T3a as compared to other T3a findings, perirenal fat invasion in 77 (48%) and renal vein invasion in 23% patients in our study population.

Multidetector CT scan has been widely used to report renal sinus fat invasion. As shown in a study done by Hallscheidt P, CT scan has a high diagnostic value in detecting renal sinus fat invasion in particular [12]. The radiological staging on CT scan was done and renal sinus fat invasion was assessed taking its diagnostic parameters by two experienced radiologists as described above.

The sensitivity and specificity for detection of renal sinus fat invasion on CT scan came out to be 88% and 73% respectively. Also, the interrater agreement shown by two readers was good with a k value of 0.856. The positive predictive value of CT scan came out to be 56.5% and negative predictive value came out to be 95.5%. It implies that the false negative rate of the multidetector CT scan is very low making it a diagnostic finding by increasing true positive rate. However, if the CT shows a lesion similar to renal sinus fat invasion, biopsy should always be done to rule out the other causes mimicking a renal sinus fat invasion. A study done by Bolster F *et al* has shown a low positive predictive value of multidetector CT scan in detecting renal sinus fat invasion (40% and 53%, and the specificity of 38% and 66.6% by two readers respectively. However, the sensitivity of CT scan was very high just as in agreement with our study [13]. Another study done by Cherry k *et al* has revealed the low positive predictive value of MDCT in detecting renal sinus fat invasion [14].

It was observed that most of patients were male, as is the case with RCC on a wider note. Mean Age of the patients presented with renal sinus fat invasion was 51 years.

The mean size of the tumor came out to be 6.4 cm that implies a larger size tumor and more than 7 cm lesions were not observed frequently in patients with stage T3a (p=0.08). So according to our results, size cannot be used as a reliable single factor in diagnosing stage T3a but can be only minimally helpful. Small sized tumors cannot rule out the presence of renal sinus fat invasion. In literature review, it is seen that the tumors with renal sinus fat invasion were larger

in size as compared to those without [13]. A study done by Sokhi Hk *et al* has also described in their study that size is not a reliable marker in detecting T3a lesions which is in agreement with our study [15].

Polarity and laterality have shown no significant relation. However, most of the lesions were located centrally. Again, study done by Sokhi HK has shown that centrally located RCC lesion has a high sensitivity and low specificity for renal sinus fat invasion. A few lesions were actually located centrally on histopathology although they did not distinguish between renal sinus fat invasion and venous invasion [15].

Renal sinus fat invasion is associated with a high mortality rate as compared with other T3a lesions. The treatment options are highly dependent on the staging of the disease and can range from organ sparing surgery to complete nephrectomy as well as conservative management is indicated in certain cases. Hence the accurate determining of the stage is mandatory [17].

6. Conclusion

Summarizing our study, renal sinus fat invasion is the most common radiological and histological finding of stage 3 RCC. The early detection of renal sinus fat invasion is necessary as it is associated with poor prognosis. Multidetector CT scan has a high sensitivity for detecting the renal sinus fat invasion. The definitive signs like irregular margin, nodular appearance of sinus fat and enhancement of tumor tissue in the sinus region are highly predictive. The specificity and positive predictive values are low. Hence MDCT is a useful tool in the exclusion of renal sinus fat invasion owing to its high negative predictive value. Although it has a good sensitivity for renal sinus fat involvement however due to low specificity and positive predictive value it cannot be totally relied upon for invasion. Other factors like size, irregular tumor margins, nodular enhancement of renal sinus fat and location of tumor lesion should also be correlated.

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