Pre-operative Imaging May Overestimate the Kidney Tumor Size

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Purpose: To compare the kidney tumor size on radical nephrectomy pathology specimen with size estimated by computed tomography (CT) scan and ultrasonography.

Materials and Methods: The tumor size on pathology specimen of 40 patients who had undergone radical nephrectomy at our center from March 2003 until March 2009 was compared with pre-operative CT scan and ultrasonography findings. The paired *t* test was used to compare the means.

Results: The participants included 40 patients, 25 men and 15 women, with the mean age of 64.12 ± 10.75 years (range, 42 to 79 years). All tumors were renal cell carcinoma. Mean tumor size on pathology specimen was 6.2 ± 1.1 cm. Mean tumor size estimated by pre-operative CT scan and ultrasonography was 7.34 ± 1.83 cm and 7.4 ± 1.96 cm, respectively ($P = .001$). Tumor stage did not affect this significant difference. There was not any significant difference between tumor size estimated by CT scan or ultrasonography ($P = .39$).

Conclusion: Computed tomography scan and ultrasonography both may overestimate renal tumor size. This point must be considered in clinical staging and treatment selection. Multicenter prospective comparison is suggested.

Keywords: kidney neoplasms, pathology, X-ray computed tomography, ultrasonography

INTRODUCTION

Tumor size is an important clinical and pathologic feature for evaluating patients with renal cell carcinoma (RCC). The pT1a, pT1b, and pT2 primary classifications are used for tumors restricted to the kidney, depending just on the tumor size.[1] Tumor size has substantial clinical implications for patients with a renal mass. Knowing tumor size leads to appropriate staging, simplifies the prediction of prognosis, and helps in choosing the best treatment modality, including observation, partial nephrectomy, or radical nephrectomy.[2] Furthermore, size of the kidney tumor and its location enjoin the surgical approach, such as nephron-sparing surgery (NSS) for smaller lesions, a flank incision for radical nephrectomy, thoracoabdominal incision for large upper pole lesions, or a transperitoneal approach for bilateral lesions operated on in one session.

Recently, tumor size is mostly represented by pathologic size, which is routinely estimated during pathologic sectioning.[2,3] Studies reporting the appropriate size cutoff for the use of NSS have used the pathologic size of the renal tumor. On the other hand, NSS is chosen as a treatment modality based on the radiologic size. Novick concluded that the tumor size has gradually gained acceptance for elective NSS.[4,5] In addition, the pathologic size is not always available in patients who are treated by percutaneous or laparoscopic ablation procedures[6,7] or laparoscopic nephrectomy with subsequent tumor morcellation.

Several previous observations suggest that there is an overestimation of pathologic size of renal tumors compared with radiographic size, which may have implications for planning NSS.[8-11] Radiographic overestimation may diminish the number of patients who would otherwise be candidates for a nephron-sparing approach.[10] The extent to which computed tomography (CT) depicts more renal masses than ultrasonography has rarely been quantified because it is difficult to obtain surgical confirmation.[12]

Due to paucity of studies comparing pathologic kidney tumor size with both ultrasonography and CT scan size, we performed this study to compare the radiographic size of the tumor by CT scanning and ultrasonography prior to the surgery with the pathologic size of the tumor after the surgery.

Table 1. Demographic characteristics of the patients.

Parameters	Patients
Mean age (range), y	64.12 (42 to 79)
Gender, n (%)	
Male	25 (62.5%)
Female	15 (37.5%)
Type of procedure, n (%)	
Open radical nephrectomy	33 (82.5%)
Laparoscopic radical nephrectomy	7 (17.5%)
Histology, n (%)	
Clear cell	31 (77.5%)
Non clear cell	9 (22.5%)
Staging, n (%)	
T1	25 (62.5%)
> T1	15 (37.5%)

MATERIALS AND METHODS

The medical records of patients treated by open or laparoscopic radical nephrectomy for localized RCC from March 2003 to March 2009 were retrospectively reviewed.

Patients with positive surgical margin, multiple tumors, imaging performed more than two months before the surgery, benign or cystic lesions, partial nephrectomy, and incomplete records were excluded from the study.

Finally, 40 patients met the inclusion criteria. Patients' demographic characteristics, including age, gender, histology, type of procedure, and cancer stage, were collected from the records. The radiologic and pathologic reports were also reviewed, and tumors were staged according to the 2002 TNM staging system.[1]

All the patients had undergone a helical intravenous contrast-enhanced abdominal CT scan and ultrasonography by an expert radiologist before the surgery, which showed a solitary renal neoplasm. The largest of diameter measurements was defined as the CT scan or ultasonography tumor size.

Tumor stage, size, and histologic subtype were determined from the pathology reports. The pathologic tumor size was defined as the largest diameter of the tumor examined after extraction of the specimen and fixation with formalin.

The mean values of CT scan, ultrasonography, and patho-

Table 2. Mean tumor size estimated by ultrasonography, CT scan, and pathology.*

	Ultrasonography	CT scan	Pathology	*P* (Ultrasonography and Pathology)	*P* (CT scan and Pathology)
T1	5.6 ± 0.53	5. 58 ± 0.65	3.97 ± 0.31	.001	.001
> T1	10.44 ± 0.66	10.26 ± 0.63	9.92 ± 0.65	.007	.002
overall	7.4 ± 1.96	7.34 ± 1.83	6.2 ± 1.1	.001	.001

*CT indicates computed tomography.

logic sizes, and their difference were calculated. Paired Student's *t* test was used to compare the mean values. The correlation between radiological and pathological sizes was also analyzed. A 5% level of significance was used for all statistical testing. Statistical analysis was performed using SPSS software (the Statistical Package for the Social Sciences, Version 18.0, SPSS Inc, Chicago, Illinois, USA).

RESULTS

Demographic characteristics of patients are shown in Table 1. Angiomyolipoma and other benign lesions were excluded from the study. The average interval from pre-operative CT scan and ultrasonography to surgery was 29.9 days (range, 1 to 60 days).

The mean pathologic, CT scan, and ultrasonography sizes are shown in Table 2. The mean radiological tumor sizes for all the 40 patients were significantly more than the pathologic size. The mean sizes for all the tumors examined were 1.14 cm and 1.2 cm larger on the CT scan and ultrasonography assessment versus the pathologic measurement (P = .001 and P = .001, respectively). Mean ultrasonographic and CT scan size difference (0.06 cm) was not statistically significant (P = .39).

There were statistically significant overestimations in renal tumor size by CT scan and ultrasonography for both T1 and > T1 stages (Table 2), but mean difference was higher in T1 stage. The mean change in size for T1 tumors was 1.61 cm larger on the CT scan assessment versus the pathologic measurement while this difference was 0.35 cm for T2 tumors. The mean size of T1 tumors was 1.63 cm larger on the ultrasonography assessment versus the pathologic measurement, while this difference was 0.52 cm for T2 tumors. Scatter plot of radiological sizes (ultrasonography and CT scan sizes) and pathological size are shown in Figures 1 and 2, respectively. According to Figures, radiological sizes correlated with pathological size.

DISCUSSION

There are several studies with conflicting results on the relationship between the radiographic and pathologic tumor

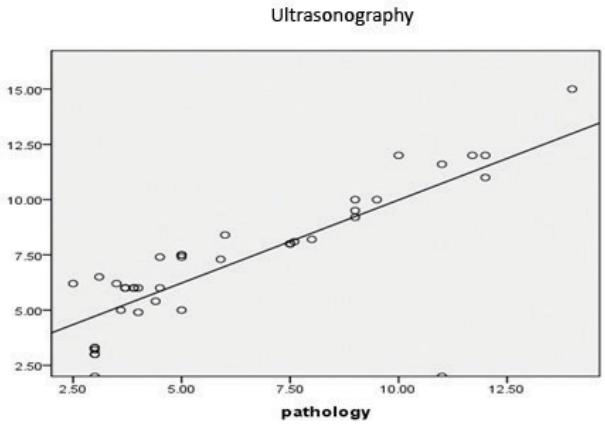

Figure 1. Regression line between pathology and ultrasonography sizes (cm).
(r = 0.80, P < .001) (R^2 = 0.644, P < .001)

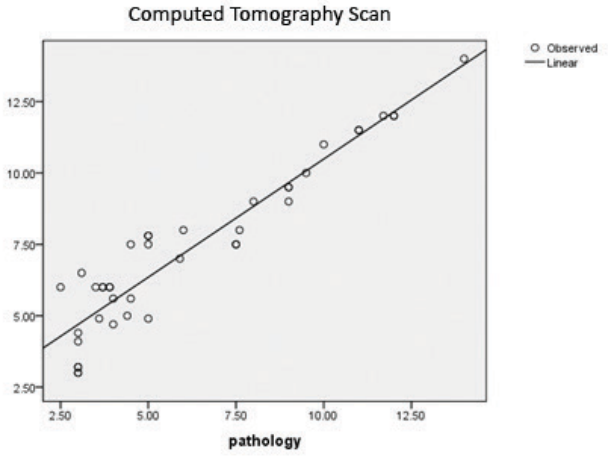

Figure 2. Regression line between pathology and computed tomography scan sizes (cm).
(r = 0.94, P < .001) (R^2 = 0.89, P < .001)

sizes.[3,8,9,13,14] Herr prospectively reviewed 50 patients who had undergone partial nephrectomy and found that the clinical tumor size (pre-operative CT) was 0.63 cm (range, 2.2 to 0.4 cm) larger than the pathologic size. Moreover, he reported that tumors ≥ 3.5 cm on CT showed a significant reduction in size. This was attributed to the loss of blood flow after ligation or occlusion of the renal artery. The decrease was more significant in the renal tumor size; however, the whole kidney shrank. This helps the surgeon resect larger tumors completely within a safe margin, regardless of the size of the kidney as a whole.[8]

In a follow-up study, Herr and coworkers found that the greatest difference was seen in clear cell carcinoma and tumors > 3 cm. They concluded that because the shrinkage was consistent, tumors with a radiographic diameter slightly larger than 4 cm could still meet the 4-cm pathologic size criterion after partial nephrectomy.[9]

Irani and coworkers retrospectively studied 100 patients with renal tumors who had undergone radical nephrectomy. They reported that the average pathologic tumor size was significantly smaller than the clinical tumor size (60 mm versus 70 mm). They also found that the smaller the tumor, the more the clinical size overestimated the pathologic size. Contradicting Herr's findings, their data showed that CT overestimated the tumor size more in smaller tumors, and the location of the tumor did not have any influence on the extent of the difference between the CT and surgical sizes of the tumor.[15]

Schlomer and colleagues noted a significant difference in tumors smaller than 5 cm.[10] Similarly, Choi and associates stated that pre-operative CT imaging may overestimate tumor size in RCCs of smaller than 6 cm.[14]

In the present study, we compared both ultrasonography and CT scan sizes with pathologic tumor size in patients with a renal mass. The present findings support those of previous reports which found that pre-operative CT may overestimate the pathologic size. While radiological sizes correlated with pathological size, renal tumors were on average 1.14 cm and 1.2 cm smaller after nephrectomy than what the CT scan and ultrasonography estimated before the surgery. Changes in radiographic and pathologic tumor sizes were more pronounced in patients with smaller tumors (stage T1), which are the best candidates for NSS.

However, in our experience, the overall difference between the CT scan and ultrasonographic sizes was insignificant, which suggests that CT imaging estimates renal tumor size in a manner that is compatible with ultrasonography. In our study, the CT scan and ultrasonography estimations of tumors were similar in all sizes, which is compatible with results that Jamis-Dow and colleagues found in small renal masses. They understood, however, that neither modality is perfect.[12] These findings mean that radiographic size of tumor shows larger view of the tumor, which may result in selecting an inappropriate treatment and a falsely worsened overall prognostic prediction.

Our study has some significant limitations: the sample size is small; formalin fixation can decrease tumor size; the design is retrospective; CT scans have been performed elsewhere; the radiologic and pathologic measurements were not done in the same geometric dimensions; and the CT scan apparatus and technicians were not the same for all the patients.

CONCLUSION

We observed a statistically significant overestimation of renal tumor sizes comparing CT scan and ultrasonography with pathology. This point must be considered in clinical staging and treatment selection. However, multicenter prospective comparison is suggested.

CONFLICT OF INTEREST

None declared.

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