Journal of BUON **14:** 235-238, 2009

ORIGINAL ARTICLE

Radiographic size versus surgical size of renal masses: Which is the true size of the tumor?

B. Alicioglu[1], M. Kaplan[2], V. Yurut-Caloglu[3], U. Usta[4], S. Levent[5]

[1]*Department of Radiology,* [2]*Department of Urology,* [3]*Department of Radiation Oncology,* [4]*Department of Pathology, Trakya University, School of Medicine, Edirne;* [5]*Department of Radiology, Midyat State Hospital, Mardin, Turkey*

Summary

Purpose: *The size of a renal neoplasm is important for staging, prognosis and selection of appropriate treatment. Our aim was to determine whether there is a discrepancy between the radiographic and pathological size of renal tumors.*

Patients and methods: *The maximum size of 35 resected renal tumors was measured by computed tomography (CT) by 2 independent observers. The radiographic and pathological sizes were compared by size range and tumor radiological features.*

Results: *Although the radiographic and pathological size for all tumors was not statistically different (7.50 vs. 6.25 cm, p=0.452), the average radiographic size was larger than pathological tumor size in tumors smaller than 7 cm. Solid tumors showed more reduction in size (17.02%) compared with cystic and necrotic tumors (p=0.731). Only the radiographic size of ill-defined tumors was smaller than their pathological size (average 33.33%; p=0.865). The influence of tumor side (left or right kidney) and its location within the kidney did not influence the degree of decrease (p=0.147 and p=0.981, respectively).*

Conclusion: *A reduction in the size of renal tumors is observed in tumors < 7 cm, which is explained by vasoconstriction during the temporary renal artery occlusion, surface hypothermia and blood loss during the operation. If this reduction of size is secondary to surgery, the radiographic size of renal tumors should be considered in staging and selecting the appropriate treatment for tumors < 7 cm for which the decision of surgical approach depends on the size of the tumor.*

Key words: computed tomography, nephrectomy, renal tumor, size, staging

Introduction

The number of diagnosed renal tumors has increased in recent years due to the increased use of noninvasive radiological imaging techniques [1]. The size of renal tumors is important for staging, prognosis and selection of the appropriate treatment. But does the preoperative radiographic size of a renal tumor correctly reflect its pathological size? [2-8]. This is an important question, especially if nephron-sparing surgery (NSS) is being considered. During the past decade, open NSS has been accepted as a safe and effective alternative to radical nephrectomy in elective situations [9]. The surgeon's decision for NSS is based on the radiologist's measurement of the tumor. By many authors, the size of 4 cm is considered to be the upper limit in size which is suitable for elective NSS. Most studies reporting the prognosis of renal tumors depend on the surgical size, rather than the radiographic size of the tumor. These two measurements may be the same although previous studies suggested conflicting results [2-8,10].

Another reason for the importance of radiographic size of renal tumors is that the pathological size is not always available in patients who are treated by laparoscopic nephrectomy with subsequent tumor morcellation [4].

The aim of this retrospective study was to evaluate the relationship between the preoperative radiographic and postoperative pathological sizes of renal tumors.

Correspondence to: Dr. Banu Alicioglu. Fatih mah. 4.cad 43.sok., Ziraatliler Sitesi B Blok no:8, 22030 Edirne, Turkey. Tel: +90 532 3660070, Fax: +90 284 2352730, E-mail: banualicioglu@trakya.edu.tr

Received 22-07-2008; Accepted 10-10-2008

Patients and methods

Thirty-two CT and 2 magnetic resonance imaging (MRI) scans of 34 patients (22 male, 12 female) treated by radical or partial nephrectomy for renal tumors from March 1999 to December 2006 were retrospectively reviewed. In total, 35 renal tumors were identified from 34 patients. Three tumors were excised by partial nephrectomy and the rest by radical nephrectomy.

All patients underwent an intravenous contrast-enhanced abdominal CT or MR scan within 4±2 weeks before surgery. Of the 34 patients, 22 underwent CT-scan at our hospital or another multislice CT, while 10 patients were CT-scanned in other centers. Two cases (3 masses) were interpreted by their MRI scans.

The films were studied by two independent investigators without knowledge of the operation and histopathological staging results. Tumor sizes were estimated by their largest diameter.

Of the 35 tumors, 21 (60%) were located in the right and 14 (40%) in the left kidney. Tumors were located at the upper pole (31.4%), the mid portion (34.2%), and the lower pole (20%) or comprised the entire kidney (14.2%). Two tumors were cystic, 18 were solid and 14 were necrotic. All tumors were grouped according to their contours as well-defined (n=24), relatively well-defined (n=4), and ill-defined (n=7) masses. Pathological tumor size was measured at its largest diameter. Of the 35 tumors, histopathological diagnosis of 23 tumors were clear-cell renal cell carcinoma (RCC), 6 other types of RCC, 3 poorly differentiated tumors, 2 oncocytomas and 1 angiomyolipoma.

Tumors were split into 3 groups according to their pathological size: < 4 cm, between 4 and 7 cm, and >7 cm. The average tumors' radiographic and pathological sizes were compared with each other in the 3 groups. The average radiographic size of the two radiologists' measurements were compared with the pathological size and their correlation was analyzed for the whole group. The influence of the tumor side (left or right), its intrarenal location, the pathological size (stage), and the contours and internal texture defined radiologically by CT measurements were analyzed and the results are listed in Table 1. For this analysis, the percentage of the size differences was chosen as the endpoint and calculated for each patient.

Statistical analysis

Data were expressed as mean ± SD. Differences between the measurements were assessed using the Wilcoxon signed rank test. Intraclass correlation (ICC) analysis was used to determine the reliability between the radiographic and the pathological sizes. A p-value <0.05 was considered statistically significant. SPSS 9.0 statistical software was used for statistical analyses.

Results

The sizes measured by both radiologists for each tumor were correlated with the pathological sizes (ICC=0.973, p <0.001 for the first and ICC=0.971, p <0.001 for the second radiologist). The tumor side, its

Table 1. Comparison of the average radiographic tumor sizes before surgery and the surgical specimen sizes after nephrectomy according to the size, contour and internal texture of the tumor

	Radiologic tumor size (cm) Mean ± SD	*Pathologic tumor size (cm) Mean ± SD*	*Difference (cm)*	*Difference* (%)*	*p-value*
Size (cm)					
<4	3.50±0.68	3.00±0.42	0.50	14.29	0.141
4-7	5.50±2.01	5.00±0.95	0.50	9.1	0.345
>7	11.00±3.62	11.00±3.14	0	0	0.755
Internal texture					
Cystic	6.95±3.20	6.0±1.50	0.95	13.67	0.593
Necrotic	9.75±3.81	9.57±3.76	0.18	1.85	0.659
Solid	6.58±3.96	6.44±3.86	1.12	17.02	0.731
Contour					
Well defined	5.75±3.81	5.25±3.67	0.50	8.70	0.410
Relatively well defined	9.25±3.21	8.00±3.35	1.25	13.51	0.715
Ill defined	9.00±4.18	12.00±3.54	–3.0	–33.33	0.865
Total (n=35)	7.25±4.05	6.50±3.94	0.75	10.35	0.452

*Difference (%): [(radiographic size-pathological size)/(radiographic size)]×100, SD: standard deviation location in the kidney and its internal texture did not influence statistically the amount of decrease (p=0.147, p=0.981 respectively).

Table 1 lists the average radiographic and pathological sizes of the tumors in the 3 groups listed according to size, internal texture and tumor contours.

Five tumors were < 4 cm, 13 were between 4 and 7 cm, and 17 were > 7 cm. The average radiographic and pathological sizes for all 35 tumors were not significantly different (p=0.452).

Although no significant difference was seen in the average radiographic and pathological tumor sizes in each group; radiographic sizes were larger than pathological sizes except for the tumors >7 cm. The largest percentage difference was found in tumors < 4 cm for which the average radiographic size was 14.29% larger than the pathological size, still without statistical significance (p=0.141).

Solid tumors showed more reduction in size compared with cystic and necrotic tumors (17.02%; p= 0.731).

Only the radiographic size of ill-defined tumors was smaller than their pathological size (average 33.33%; p=0.865). Left or right kidney tumor location and tumor location within the kidney did not influence statistically the degree of decrease.

Discussion

The clinical size of a renal tumor is an important factor for staging and selecting the appropriate treatment. According to TNM system (American Joint Committee on Cancer, 2002) the distinction of stage T1a, T1b and T2 tumors is based entirely on tumor size. A diameter of 7 cm is the cutoff value between stage T1 and T2. T1 stage is further divided into T1a and T1b for tumors smaller or larger than 4 cm [11-16]. In addition, the preoperative decision for or against NSS is made according to the clinical tumor size. Even small differences between radiographic and pathological sizes are very important; miscalculation of the radiographic size might influence the choice of treatment, especially for patients with stage T1 tumors or for patients who are candidates for partial nephrectomy [4,9].

A number of investigators have previously demonstrated that a size discrepancy often exists between the preoperative radiographic measurements of renal lesions and postoperative pathological sizes in stage 1 and 2 tumors. They all reported that preoperative CT may overestimate the pathological size. This reduction was explained by loss of flow within the rich vasculature of the tumor, vasoconstriction, surface hypothermia and the temporary renal artery occlusion during the operation [2-8]. Based on the fact of shrinkage, Kanofsky et al. [5] proposed the correct measurement of radiological size rather than the pathological size should be considered for renal cancer staging.

Herr et al. indicated that the average decrease in the tumor size after partial nephrectomy was 0.74 cm [3]. In another study of the same author, tumors that were estimated as ≥3.5 cm on CT, decreased in size significantly more than tumors <3.5 cm and tumors in the upper third of the kidney decreased significantly less [7]. Schlomer et al. results were similar. They found that the larger difference was in the 4-5 cm range ($p < 0.05$) [2].

Herr et al. [3] hypothesized that the shrinkage of tumors after excision was not a true reduction in tumor size but it was secondary to decreased vascularity within the tumor. The entire kidney shrinks after renal artery ligation, but the decrease in the renal tumor size is more significant. A likely reason is the richer tumor vasculature compared with the healthy kidney. Kanofsky et al. [5] evaluated 236 renal cancers consisting of T1 and T2 stage and concluded that 52% of them had regressed in size. They compared the reduction in terms of histology and concluded that clear cell renal tumors are more downstaged than papillary and chromophobe renal cell carcinomas.

These results contradict Yaycioglu et al. [4] and Irani et al. [6] studies whose data showed that CT overestimated the tumor size in tumors ≤3.5 cm. Additionally, they both did not identify any influence of intrarenal location.

Our results were similar to Yaycioglu et al. [4] and Irani et al. [6] studies. The average radiographic size was 7.25±4.05 cm and the average pathological size 6.50±3.94 cm. Although without statistical difference (p=0.452), the average radiographic size was slightly larger than the pathological size. The size difference was more significant in the tumors <4 cm (a decrease of 14.29%). In our study, the decrease rate of tumors < 4 cm was lower than in previous studies. This can be explained by the fact that there is a small number of patients in this group and partial nephrectomy was carried out in 3 patients only.

The difference between the average radiographic size and pathological size was more significant in solid tumors (17.02%) compared to cystic and necrotic tumors. This result supports the vasoconstriction and the surface hypothermia hypothesis explaining the shrinkage of the tumor. As renal cell tumors are hypervascular, the shrinkage of solid tumors is an expected finding.

Our study revealed that the average radiographic size of tumors ≥7 cm equaled the pathological size.

However, CT overestimated the sizes of ill-defined tumors. The radiological sizes of tumors invading the perinephric tissues are more frequently smaller than the pathological size. This overestimation might be due to the close relation and mass effect of the adjacent structures. Pyelonephritis, hemorrhage and hematoma within or around the tumor, cyst formation, and presence of adjacent cysts or dilation of adjacent calyces, invasion of the collecting system may cause inaccuracies between the radiological and pathological sizes of the tumors. Thus, the presence of such conditions should be taken into consideration during the interpretation of the radiological tumor size [5,8]. The growth of the tumor that occurred between CT and the operation or erroneous radiological measurement are additional reasons of overstaging [5].

As this study is a retrospective one, blood loss, presence of pyelonephritis, cysts or hematoma were not analyzed. Because our institution is a tertiary care facility, many of the radiologic studies were done at other institutions. Measurement errors, differences in transverse diameter, orientation and differences of planes between CT and pathological sections as well as different CT techniques might very likely influence the results.

Volumetric studies obtained by multislice CT should provide more precise measurements in the preoperative tumor assessment. Most importantly the limited number and heterogeneity of the tumors, chiefly the low number of tumors < 4 cm are the major weaknesses of our study.

Staging and treatment decisions depend on the size of the tumor. A reduction in renal tumor size is commonly observed at surgical resection especially in solid tumors and tumors smaller than 4-7 cm in size. Further experimental and/or prospective studies showing both tumoral and renal size alterations *in vivo* and *ex vivo* can clarify the tumor shrinkage. The amount of hemorrhage during the operation and postoperatively has to be determined. The sizes of the tumor intraoperatively, just after the resection and at the pathology laboratory should be compared to define the effect of hypothermia. This reduction was explained by loss of flow within the rich vasculature of the tumor, vasoconstriction, surface hypothermia and the temporal renal artery occlusion during the operation. Finally, as the reduction is consistent, tumors with a radiographic diameter slightly larger than 4 cm still meet the 4 cm pathological size criterion after partial nephrectomy and if this reduction of size is secondary to surgery, the radiographic sizes of the renal tumors should be considered as real size in staging and selecting the appropriate treatment for tumors well defined, solid and smaller than 7 cm in diameter.

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