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Correlation between Radiologic and Pathologic Tumor Size in Localized Renal Cell Carcinoma

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Purpose: To evaluate the accuracy of radiologic tumor size for making decisions regarding nephron-sparing surgery of localized renal cell carcinomas (RCCs), we compared tumor size measured by a preoperative radiologic modality with that measured in the pathologic specimen.

Materials and Methods: Between January 2003 and December 2007, a total of 186 patients with pT1 or pT2 RCC underwent radical or partial nephrectomy at our institute. We excluded 11 patients who had preoperative arterial embolization (n=9) or positive surgical margins (n=2), and a total of 175 patients were included in this study. Radiologic size was defined as the largest diameter on computed tomography (CT), and pathologic size was defined as the largest diameter of the surgical specimen of the tumor. We retrospectively analyzed the difference between radiologic and pathologic tumor size.

Results: The radiologic and pathologic tumor sizes did not significantly differ (4.98±2.82 cm vs. 4.55±2.70 cm, respectively, p=0.152). In the subgroup analysis, the size difference was statistically significant only for tumor sizes of less than 6 cm. The size difference was largest in tumors of 3 to 4 cm, for which mean the radiologic size was 0.63±1.19 cm larger than the mean pathologic size (p=0.002). Histologic type had no significant influence on the difference between radiologic and pathologic size.

Conclusions: The tumor size of RCCs in preoperative CT seems to correlate well with pathologic tumor size. However, CT imaging may overestimate the size of a tumor in the small mass group (less than 6 cm). These results should be considered when making decisions about nephron-sparing surgery.

Key Words: *Renal cell carcinoma; Nephrectomy; Radiology*

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INTRODUCTION

Tumor size is known as an important prognostic factor in localized renal cell carcinoma (RCC), and staging and selection of an appropriate treatment depend on the size of the tumor [1]. Most research on the prognostic value of tumor size has been based on pathologic size rather than radiologic size [2,3]. On the other hand, treatment including nephron-sparing surgery (NSS) is decided upon according to radiologic size. Novick reported that, with the accumulation of longer-term data, a size criterion has gained gradual acceptance for elective NSS [4]. He also reported that radical nephrectomy and NSS are equally effective curative treatments for patients who present with a single, small (<4 cm), and clearly localized RCC (4-6 cm). In his opinion, although the long-term functional advantage of NSS when there is a normal opposite kidney remains to be shown definitively, the benefits of maximal nephron preservation may include a decreased risk of progression to chronic renal insufficiency and end-stage renal disease. Therefore, it is important to define the correlation and agreement between radiologic size and pathologic size, especially for patients who are candidates for NSS of a localized RCC. We studied the relationship between radiologic tumor size, as determined by preoperative computed tomography (CT), and pathologic tumor size from a renal surface series.

MATERIALS AND METHODS

The medical records of 186 patients treated by radical nephrectomy or partial nephrectomy for localized RCC from January 2003 to December 2007 were retrospectively reviewed. We excluded 11 patients who had preoperative arterial embolization (n=9) or positive surgical margins (n=2), and a total of 175 patients were included in this study.

All patients underwent an intravenous contrast- enhanced abdominal CT scan before surgery, and the results of that were interpreted by a single experienced abdominal imaging radiologist.

The CT was the 16-channel multidetector type and the slice thickness was 0.5 mm. The size of the tumor on CT was measured in four axes: superior to inferior, anterior to posterior, oblique, and left to right. The largest of these four measurements was defined as the radiologic tumor size. The pathologic tumor size was defined as the largest diameter of the tumor examined just after extraction of the specimen without formalin fixation. In patients with multiple unilateral tumors of the same histologic subtype, the largest tumor was included. The tumors were divided into size ranges by radiologic size. The mean values of radiologic sizes, pathologic sizes, and the difference were calculated. Student's t-test was used to compare the mean values. A 5% level of significance was used for all statistical testing, and all statistical tests were two-sided.

TABLE 1. Characteristics of the 175 patients with localized renal cell carcinomas

Characteristics	No. of patients (%)
No. of patients	175
No. of male/female	116/59
Mean age, years (range)	54.0 (14-79)
Average tumor size (cm, Mean±SD)	
Radiologic	4.98±2.82
Pathologic	4.55±2.70
Pathologic stage	
pT1a	100 (57)
pT1b	50 (29)
pT2	25 (14)
Histologic type	
Clear	147 (84)
Chromophobe	13 (7)
Papillary	11 (6)
Sarcomatoid	4 (3)
Nephrectomy type	
Radical	154 (88)
Partial	21 (12)
Fuhrman grade	
I	3 (2)
II	119 (68)
III	46 (26)
IV	7 (4)

RESULTS

The mean patient age was 54.0 years (range, 14-79 years); of 175 patients, 116 were men and 59 were women. The characteristics of the 175 patients with localized RCCs are shown in Table 1.

The mean radiologic and pathologic tumor sizes for all 175 patients did not differ significantly (4.98±2.82 cm vs. 4.55±2.70 cm, respectively, p=0.152). Table 2 lists the mean radiologic and pathologic sizes of the tumors, which were divided into 1 cm ranges by radiologic size. The mean radiologic tumor size was larger than the pathologic tumor size for all sizes. In particular, in tumors less than 6 cm, the difference between radiologic and pathologic tumor size was statistically significant ($p < 0.05$). The largest difference was for tumors 3 to 4 cm in size, for which the mean radiologic size was 0.63±1.19 cm larger than the mean pathologic size (p=0.002). No significant difference was seen between the radiologic and pathologic tumor size for tumors larger than 6 cm (Table 2).

Table 3 shows the mean radiologic and pathologic sizes of tumors divided into pT1a, pT1b, and pT2 groups. In pT1a and pT1b tumors, the difference between mean radiologic and pathologic tumor size was statistically significant (0.45±0.82 cm and 0.50±0.73 cm, respectively; p=0.002, p=0.011). However, in pT2 tumors, no significant differ-

TABLE 2. Differences in radiologic and pathologic tumor size according to radiologic size range

Radiologic size range (cm)	No. of patients	Pathologic tumor size (cm, Mean±SD)	Radiologic tumor size (cm, Mean±SD)	Difference (cm, Mean±SD)	p-value
≤1	6	0.78±0.12	0.93±0.08	0.15±0.08	0.039[a]
1.1-2.0	9	1.53±0.24	1.93±0.30	0.40±0.52	0.028[a]
2.1-3.0	33	2.33±0.25	2.61±0.26	0.28±0.42	0.003[a]
3.1-4.0	36	3.27±0.23	3.90±0.28	0.63±1.19	0.002[a]
4.1-5.0	29	4.20±0.24	4.70±0.26	0.50±0.47	<0.001[a]
5.1-6.0	20	5.14±0.24	5.59±0.24	0.46±0.83	0.037[a]
6.1-7.0	13	6.15±0.24	6.67±0.26	0.52±0.91	0.057
>7	29	9.46±2.44	9.67±2.78	0.21±1.24	0.770
Total	175	4.55±2.70	4.98±2.82	0.43±0.88	0.152

SD: standard deviation, [a]: statistically significant

TABLE 3. Differences in radiologic and pathologic tumor size according to pathologic stage

Pathologic stage	No. of patients	Pathologic tumor size (cm, Mean±SD)	Radiologic tumor size (cm, Mean±SD)	Difference (cm, Mean±SD)	p-value
pT1a	100	2.82±0.82	3.27±1.20	0.45±0.82	0.002[a]
pT1b	50	5.37±0.81	5.87±1.07	0.50±0.73	0.011[a]
pT2	25	9.85±2.41	10.04±3.05	0.19±1.32	0.810
Total	175	4.55±2.70	4.98±2.82	0.43±0.88	0.152

SD: standard deviation, [a]: statistically significant

TABLE 4. Differences in radiologic and pathologic tumor size according to histologic type

Histologic type	No. of patients	Pathologic tumor size (cm, Mean±SD)	Radiologic tumor size (cm, Mean±SD)	Difference (cm, Mean±SD)	p-value
Clear cell	147	4.44±2.38	4.93±2.49	0.49±0.84	0.850
Non clear cell	28	5.15±4.05	5.22±4.29	0.07±1.02	0.946
Total	175	4.55±2.70	4.98±2.82	0.43±0.88	0.152

SD: standard deviation

ence was seen between radiologic and pathologic tumor size (p=0.810) (Table 3). Table 4 lists the mean radiologic and pathologic sizes of tumors divided by histologic type into the clear cell type and non clear cell type. In both groups, the mean radiologic tumor size was larger than the pathologic tumor size (0.49±0.84 cm vs. 0.07±1.02 cm), but there was no significant difference between the two groups (p=0.850, p=0.946) (Table 4).

DISCUSSION

The increased usage of advanced imaging techniques such as ultrasonography or CT has led to an increase in incidental tumors, and the size of incidental tumors tends to be smaller [5,6]. Lightfoot et al reported that incidental RCC was only 17.5% in the period of 1970 to 1981, but 82.8% in the period of 1982 to 1993, when ultrasonography and CT were introduced in clinical practice [7]. Recently, it was reported that the rate of incidental tumors has increased about 40.1% to 46.4%, even in Korea [8-10]. With this increase in incidental localized RCC and decrease in tumor size, the treatment modality of RCC has changed. The frequency of NSS, such as partial nephrectomy or cryoablation, and radio frequency ablation, has increased as opposed to radical nephrectomy.

Previously, NSS had only been performed if radical nephrectomy was not indicated absolutely or relatively, such as with a bilateral RCC, solitary kidney, severe medical disease, or renal stone, and successful outcomes were reported in some cases [11,12]. Hafez et al recommended that tumor size be used as an indication for NSS. They reported that patients with renal tumors less than 4 cm have better outcomes than do those with tumors greater than 4 cm when NSS is performed [13]. However, Leibovich et al reported that there were no significant differences in recurrence or distant metastases between patients treated with NSS for RCCs less than 4 cm or RCCs of 4 to 7 cm that were exophytic or did not reach the collecting system [14]. Manikandan et al reported that NSS seems to be as effective as radical nephrectomy in patients with RCCs up to 4 cm [15]. Nam et al reported that there were no significant differences in complications, recurrence, or metastasis between patients treated with NSS for RCCs less than 4 cm or RCCs of 4 to 7 cm [16].

The radiologic size of renal tumors is an important factor in the decision for NSS; thus, several studies have examined the relationship between radiologic and pathologic tumor sizes, with varying results. Herr prospectively investigated 50 patients treated with partial nephrectomy and found that the radiologic tumor size was 0.63 cm larger than the pathologic size and attributed this difference to decreased tumor vascularity after renal artery clamping [17]. Schlomer et al reported that a significant difference was noted in tumors less than 5 cm, although the mean radiologic and pathologic tumor size for all 133 RCC patients was not significantly different [18]. They also found that the largest difference was for tumors in the range of 4 to 5 cm, which may affect decisions to perform NSS in certain patients. In our study, the mean radiologic tumor size was larger than the pathologic size for all 175 patients, but not significantly so. In tumors in the range of less than 6 cm, mean radiologic tumor size was significantly larger than mean pathologic size, and the difference was largest in tumors of 3 to 4 cm.

Kanofsky et al retrospectively reviewed 236 patients with RCC treated with radical or partial nephrectomy and found that radiologic tumor size was commonly overestimated; this was more frequently observed for clear cell type tumors than for other tumor types, such as papillary or chromophobe type [19]. Yaycioglu et al also reported similar results [20]. In our study, we found that mean radiologic tumor size was larger than mean pathologic tumor

size for both clear cell and non?clear cell type tumors, but there was no significant difference between the two groups. This study had the disadvantage of a relatively small number of patients, because the research was conducted at a single center. However, as discussed in the Introduction, investigating the relationship between radiologic and pathologic tumor size has implications for determining with assurance when to perform NSS, especially for patients who are candidates for NSS of a localized RCC.

Mindful of the results of our study, we are confirming the plan for surgical management whether patients with T1 stage RCC in our cancer center undergo radical nephrectomy or NSS. Additional study should be taken into consideration when interpreting the relationship between radiologic and pathologic tumor size. We are making progress in a standardized prospective study analyzing radiologic and pathologic tumor characteristics along with prognosis, which will help to more definitively characterize the relationship between clinical and pathologic tumor size.

CONCLUSIONS

Preoperative CT imaging may overestimate tumor size in RCCs of less than 6 cm. This result may enable us to perform NSS with assurance in certain patients with localized RCC. A prospective study that includes a comparison of prognosis is needed to definitively characterize the proper use of clinical tumor size when making decisions regarding NSS.

Conflicts of Interest

The authors have nothing to disclose.

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